

Total Pages—5

(Set-L)

**B.Tech-3rd**

**Metallurgical Thermodynamics and Kinetics**

*Full Marks : 70*

*Time : 3 hours*

Answer **Q.No.1** and any **five** from of the rest questions

*The figures in the right-hand margin indicate marks*

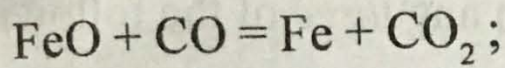
1. Answer the following questions :  $2 \times 10$

- (i) What do you mean by standard state of a system ?
- (ii) What do you mean by degree of reduction ?
- (iii) What is internal energy of a system ?
- (iv) What is basic principle of TGA ?
- (v) What is Henry's law ?
- (vi) What is the relation between internal energy, heat and work ?

( Turn Over )

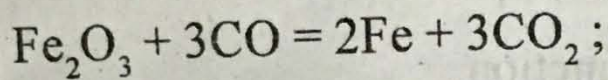
- (vii) What is the equilibrium constant for the reaction  $\text{PCl}_5 = \text{PCl}_3 + \text{Cl}_{2(g)}$  in terms of activity and partial pressure.
- (viii) What is reversible process ?
- (ix) What do you mean by triple point ?
- (x) What do you mean by temperature dependence of entropy ?
2. (a) What is an ideal solution ? Explain the important characteristics of an ideal solution in terms of : 5
- (i) Thermodynamic chemical potential
  - (ii) Enthalpy and
  - (iii) Entropy increase of a component
- (b) The reduction of iron oxide in the blast furnace proceeds according to the following reactions : 5
- $$3\text{Fe}_2\text{O}_3 + \text{CO} = 2\text{Fe}_3\text{O}_4 + \text{CO}_2 ;$$
- $$\Delta H^\circ_{298} = -12.7 \text{ k.cal}$$
- $$\text{Fe}_3\text{O}_4 + \text{CO} = 3\text{FeO} + \text{CO}_2 ;$$
- $$\Delta H^\circ_{298} = + 9.8 \text{ k.cal}$$

( 3 )



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

Calculate  $\Delta H^\circ_{298}$  for the reaction



3. (a) Derive expression for entropy change of perfect gas. Discuss the important characteristics of entropy. 3 + 2

- (b) Find the increase in molar entropy of copper when it is heated from  $127^\circ\text{C}$  to  $927^\circ\text{C}$ . The molar Sp. Heat of copper is given by  $C_p = 6.2 + 0.0017T$ . 5

4. (a) Derive Gibbs Helmholtz equation

$$\left[ \frac{\partial(\Delta G / T)}{\partial T} \right]_P = -\Delta H / T^2 . \quad 5$$

- (b) The latent heat of fusion of ice at  $0^\circ\text{C}$  is 1440 cal and the heat capacity of ice and water are 8.7 and 80 calories per mole. Calculate the change in Gibbs potential in the freezing of a mol of water at  $-20^\circ\text{C}$ . 5

5. Write short notes on any *three* of the following : 10

(i) Activity

(ii) Partial molal quantities.

(iii) Excess function

(iv) Ellingham-Richardson diagram

(v) Johnson-Mehl equation.

6. (a) What do you mean by fugacity? From  $P$ - $V$  isotherm how departure from fugacity is explained. 5

(b) What is chemical potential. Derive Gibb's Duhem relations. 5

7. (a) What do you mean by topo-chemical pattern of reaction. Discuss the significance of activation energy in a chemical reaction. 6

(b) Assuming aluminothermic reduction of  $\text{Cr}_2\text{O}_3$  is a first order reaction, the rate constant is found to be  $7.0 \times 10^{-4}$  at  $57^\circ\text{C}$ . Calculate the energy of activation and its specific reaction rate at  $127^\circ\text{C}$ . 4

8. (a) What do you mean by fugacity? Derive quantitative definition of fugacity

$$f = P \cdot e^{-\frac{A}{RT}} \text{ from } P-V \text{ isotherm.} \quad 2 + 4$$

- (b) What is Dulong-Petit law. If the specific heat of copper is 0.096671 and that of silver is 0.05582 cal/g/°. What will be the value of specific heat of an alloy of 60% Cu and 40% silver? 4