VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING
SESSION 2014-15 (ODD SEMESTER), SUPPLEMENTARY

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 × 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 $PCl_5 = PCl_3 + Cl_{2(g)}$ 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

$3Fe_2O_3 + CO = 2Fe_3O_4 + CO_2$;

$\Delta H^\circ 298 = -12{\cdot}7$ k.cal

$Fe_3O_4 + CO = 3FeO + CO_2$;

$\Delta H^\circ 298 = +9{\cdot}8$ k.cal

$FeO + CO = Fe + CO_2$;

$\Delta H°298 = -4{\cdot}4$ k.cal

Calculate $\Delta H°298$ for the reaction

$Fe_2O_3 + 3CO = 2Fe + 3CO_2$;

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°C to 927°C. The molar Sp. Heat of copper is given by $C_p = 6{\cdot}2 + 0.0017T$. 5

4. (*a*) Derive Gibbs Helmholtz equation

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

(*b*) The latent heat of fusion of ice at 0°C is 1440 cals 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°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. Deribe 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 Cr_2O_3 is a first order reaction, the rate constant is found to be $7{\cdot}0 \times 10^{-4}$ at 57°C. Calculate the energy of activation and its specific reaction rate at 127°C. 4

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

$f = P.e^{-\frac{A}{RT}}$ from P-V isotherm. 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/0°. What will be the value of specific heat of an alloy of 60% Cu and 40% silver? 4
