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Total number of printed pages – 4

B. Tech.  
PCMT 4202

### Third Semester Examination – 2010

#### METALLURGICAL THERMODYNAMICS AND KINETICS

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. (a) State true or false and give correct statement to false one: 1 × 10
- (i) In an irreversible process  $T.dS - dE - dW > 0$
  - (ii) Heat of formation of an element in its standard state is unity.
  - (iii) Kinetics gives idea about the physibility of a chemical reaction.
  - (iv) More negative the free energy more stable the metal oxide.
  - (v) In an idea gas fugacity and pressure are inversely proportional.
  - (vi) In molecular form Hydrogen gas dissolves in metals.
  - (vii) Ideal solution does not obey Rault's law
  - (viii) Spontaneous process are irreversible.
  - (ix) Entropy is a state function.
  - (x) Gas-solid reaction is an interfacial reaction.

P.T.O.

(b) Differentiate between the following (any four) : 2.5×4

- (i) Activity and fugacity
- (ii) Isothermal process and Isochoric process.
- (iii) Extensive and Intensive properties.
- (iv) Ideal and non-ideal solution.
- (v) Molecularity and Order of reaction.
- (vi) Reversible and irreversible process.

2. (a) What do you mean by nucleation and grain growth model? Derive the expression  $\log \log[1/(1-\alpha)] = n \log t + n \log k' - \log 2.303$ . From this relation how the order of the reaction can be obtained? 2+3+1

(b) For the oxidation reaction of <Pb> to <PbO> calculate the standard heat of formation of <PbO> at 427°C from the following data : 4

$$\Delta H_{298}, \langle \text{PbO} \rangle = -52.4 \text{ kcal/mol}$$

$$C_p, \langle \text{PbO} \rangle = 10.6 + 4.0 \times 10^{-3} T \text{ cal/deg/mole}$$

$$C_p, \langle \text{Pb} \rangle = 5.63 + 2.33 \times 10^{-3} T \text{ cal/deg/mole}$$

$$C_p, (\text{O}_2) = 7.16 + 1.0 \times 10^{-3} T - 0.4 \times 10^{-5} T^{-2} \text{ cal/deg/mole}$$

Melting point of Pb is 327°C

Latent heat of fusion of lead is 4.81 kJ/mol.

3. (a) What do you mean by escaping tendency of a system ? 3
- (b) What is fugacity ? Express fugacity of a non-ideal gas justifying actual pressure of the gas is the geometric mean of the fugacity and the pressure which it would exert if it behaved ideally. 2+5
4. (a) What do you mean by topochemical reaction ? What is activation energy discuss its role in a chemical reaction ? 2+4
- (b) What are the different kinetic steps involve in gaseous reduction of hematite ore ? Suggest the rate controlling steps. 3+1
5. (a) Justify the statement : "decrease in free energy gives maximum work and decrease in Gibb's potential during isothermal, isobaric process gives network". 6
- (b) What do you mean by one weight percentage standard state ? How  $\Delta G_h^\circ$  is evaluated ? 4
6. Derive following thermodynamic relations : 10
- (a)  $S = C_p \ln V + C_v \ln P + \text{Constant}$
- (b)  $C_p - C_v = R$
- (c)  $(\delta T / \delta P)_s = (\delta V / \delta S)_p$
7. Write short notes on any *three* of the following : 10
- (a) Ellingham – Richardson diagrams.
- (b) Solid Electrolyte.
- (c) Temperature dependence of entropy.
- (d) Topo-chemical reaction.
- (e) Gibbs-Duhem Equation.

8. (a) What is the basic principle of Differential Thermal Analysis ? Discuss the theory of DTA. 3+2
- (b) Discuss the basic principle of Thermo Gravimetric Analysis (TGA). Explain how with the help of TGA plot proximate analysis of coal can be determined. 3+2