

MME JUL 2016

Full Marks : 70

Time : 3 hours

Answering of Q. No. 1 is compulsory. Answer  
 any five questions from the rest.

All parts of a question should be answered at one place

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

1. Answer any *ten* questions : 2 × 10

- (a) Differentiate between reversible and irreversible process.
- (b) What is the relation between internal energy, heat and work ?
- (c) Does the heat capacity at constant pressure vary with temperature ? Explain.
- (d) Differentiate between Activation Energy and Internal Energy.
- (e) What do you mean by degree of reduction of iron ore ?
- (f) Differentiate between adiabatic and closed system.

- (g) What do you mean by Chemical potential of a substance ?
- (h) What is Hess's law of constant heat summation ?
- (i) Outline importance of kinetics in process metallurgy.
- (j) What is the basic principle of DTA ?
- (k) What do you mean by regular solution ?
- (l) What do you mean by fugacity ?
- (m) Differentiate between homogeneous and heterogeneous system.

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

- (a) Johnson-Mehl equation
- (b) Transformation formula
- (c) Partial molal quantities
- (d) Ellingham-Richardson diagram.
- (e) Solid Electrolyte.

3. (a) What do you mean by fugacity? Derive quantitative definition of fugacity  $f = P \cdot e^{\frac{A}{RT}}$  from P-V isotherm. 2 + 4
- (b) Calculate the standard emf of a Denial Cell which is working at 25 °C with standard free energy change of the cell reaction  $\Delta G^\circ$  is -413.75 kJ/mol at STP. 4
4. (a) In an isothermal process enthalpy of an ideal gas is independent of pressure, justify from Maxwell's relation. 6
- (b) Calculate the standard entropy of solid copper at 1063 °C from the following data : 4
- $S^\circ_{300}, < \text{Cu} > = 8.0 \text{ cal/deg/mole}$   
 $C_p, < \text{Cu} > = 5.41 + 1.50 \times 10^{-3} T \text{ cal/deg/mole}$
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  $< \text{CaO} > + (\text{CO}_2) = < \text{CaCO}_3 >$  at 600 °C from the following data : 5

The values of  $\Delta H^\circ F$  at 298 K for  $< \text{CaO} >$ ,  $(\text{CO}_2)$  and  $< \text{CaCO}_3 >$  (in kJ/mole) are -634.3, -393.5 and -1206.7 respectively.

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

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

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

6. (a) Deduce equation for the combined statement of 1st and 2nd law of thermodynamics. 5
- (b) State Henry law. Raoult's law appears to be a special case of Henry's law for pairs of closely related substance, justify. 5
7. Derive following thermodynamic relations (any two) : <http://www.odishastudy.com> 2 × 5
- (a)  $S = C_p \ln V + C_v \ln P + \text{constant}$
- (b)  $C_p - C_v = R$
- (c)  $(\delta T / \delta P)_S = (\delta V / \delta S)_P$

8. (a) What is an ideal solution ? Derive necessary equation for free energy change in the formation of an ideal solution. 5
- (b) What are the important steps involve in the iron ore reduction by carbon monoxide. Give comments on pore steps in the above reduction. 5
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