



Name :

Roll No. :

Invigilator's Signature :

**CS/B.TECH (CT)/SEM-3/CH(CT)-301/2009-10
2009**

CHEMICAL THERMODYNAMICS & KINETICS

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

$$10 \times 1 = 10$$

- i) Which of the following is the responsible for spontaneity of a reaction ?
 - a) ΔH is the only the guiding factor
 - b) ΔS is the only the guiding factor
 - c) ΔH and ΔS both are the guiding factors at a constant temperature
 - d) None of these.
- ii) Solid state reaction is characterized by
 - a) never be completed
 - b) fraction converted *vs* time curve always gives exponentials
 - c) diffusion controlled
 - d) none of these.



- iii) The plot of C_p / T vs T gives
 - a) linear
 - b) one maximum and one minimum
 - c) exponential
 - d) none of these.
- iv) The eutectic of a binary system involves
 - a) equilibrium between two solids and liquid
 - b) decomposition of a solid
 - c) solid-liquid interaction
 - d) none of these.
- v) In a consecutive elementary reaction, $A \rightarrow B \rightarrow C$
 - a) the concentration of A does not vary with time
 - b) the concentration of B increases first and attain a maximum and then decreases
 - c) the concentration of C gradually decreases with time
 - d) none of these.
- vi) X vs t plot of a diffusion controlled reaction is
 - a) linear
 - b) parabolic
 - c) passing through maximum
 - d) none of these.
- vii) The rate of decomposition of limestone strongly affect with crystallite size at
 - a) low temperature b) high temperature
 - c) moderate temperature d) none of these.
- viii) The decomposition rate of limestone
 - a) decreases with partial pressure of CO_2
 - b) increases with partial pressure of CO_2
 - c) does not depend on partial pressure of CO_2
 - d) depends on surface characteristics of limestone powder.



- ix) Configurational entropy depends on
- total number of lattice sites
 - number and arrangement of atom and vacant sites
 - number of vacant sites
 - none of these.
- x) First order reaction is always characterized by
- completion at finite time
 - never be completed
 - proceed in fast rate
 - none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* from the following. $3 \times 5 = 15$

- Deduce Gibb's Duhem equation and explain the significance of each equation.
- Discuss thermodynamically controlled and kinetically controlled product mentioning energy profile diagram.
- C_p of Al_2O_3 is given by $C_p = 106.6 + 0.0178T - 285000T^{-2}$ in the temperature range of 298 K to 1800°K and its enthalpy of formation from its elements at 298 K is -1675.7 kJ/mole. Calculate the enthalpy content of Al_2O_3 .
- Define partial molal volume. What is its utility in glass making process ?
- Draw a typical fraction decomposition *vs* time plot for solid phase thermal decomposition reactions and interpret the curve in terms of nucleation and growth of product phase on a single crystal of reactant.



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) What is thermodynamic probability ? How is it related with entropy ? Calculate entropy change with introducing 10^{20} number of vacancies in a g mole of a perfect crystal ($k = 1.38 \times 10^{-23}$). $2 + 1 + 4$
 b) How activation energy of decomposition of limestone is measured by measuring the weight loss and equilibrium weight loss as different isotherm ? How equilibrium weight loss is experimentally measured ? $5 + 3$
8. Write short notes on any *three* of the following : 3×5
 a) Ellingham diagram
 b) Interdiffusion of solids
 c) Temperature dependence of chemical reaction rate
 d) Phase rule.
9. a) Write Kirchhoff's equation and explain its significance. Discuss Van't Hoff equation and hence explain how enthalpy change for a heterogeneous reaction can be determined. $2 + 1 + 5$
 b) "Formation of mullite from Al_2O_3 and SiO_2 powder is a diffusion controlled process" — how would you prove it ? If the activation energy (Q) is 50 k.cal/mole and the reaction proceeds to 10% of completion at 1400°C in 1 hr., how far will it go in 1 hr. at 1500°C ? $3 + 4$
10. a) Give an expression for boundary layer thickness for the corrosion of a refractory in molten slag. Discuss the factors which affect the conversion rate. $5 + 3$
 b) What is phase diagram ? Discuss with example of eutectic and peritectic type reaction in ceramics system. $2 + 5$
11. a) The standard free energy change for decomposition of CaCO_3 is $\Delta G^\circ = 40,200 - 35.6 T$ (in cal/mole). Calculate the partial pressure of CO_2 at 900°C . 7
 b) Write an expression of decomposition kinetics of a particle of cylindrical geometry. Discuss the effect of temperature and crystallite size on the decomposition rate. $2 + 6$