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

Total Pages—4

B.Tech/3rd/MM
Metall. Thermodynamics and Kinetics

Full Marks : 70

Time : 3 hours

Answering of **Q.No.1** is essential. All parts of a question should be answered at one place

The figures in the right-hand margin indicate marks

1. Answer *all* questions : 2×10

(*a*) How does thermodynamics differ from kinetics ?

(*b*) Define the terms enthalpy and internal energy.

(*c*) State different forms of first law of thermodynamics.

(*d*) Differentiate between homogeneous and heterogeneous systems.

(*e*) Define the term fugacity.

(*f*) Outline the importance of equilibrium constant.

(Turn Over)

(*g*) Outline the significance of statistical interpretation of entropy.

(*h*) Outline the properties of ideal solutions.

(*i*) Define the term regular solution.

(*j*) Write down the names of different factors that affect the reaction rate kinetics.

2. (*a*) Discuss briefly the applications of first law of thermodynamics for isobaric and adiabatic processes.

(*b*) Comment on the entropy change associated with the following processes :

(*i*) Reversible and irreversible processes

(*ii*) Graphitization of petroleum coke. 5 + 5

3. (*a*) Derive necessary equations for the combined statements of first and second laws of thermodynamics.

(*b*) Derive necessary equation for the variation of entropy with temperature under isobaric condition. 5 + 5

(*Continued*)

4. (*a*) How does free energy change predict about the feasibility of a reaction ?

(*b*) The standard free energy change (ΔG°) for the reaction $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$ at 1173 K is −14.76 kJ. Calculate the following :

(*i*) The equilibrium constant at 1173 K

(*ii*) The equilibrium pressure of hydrogen if that of the water vapour is 0.0065 atmosphere at 1173 K. 4 + 6

5. (*a*) Using Maxwell's relation, prove that the enthalpy of an ideal gas at constant temperature is independent of its pressure, i.e. $(\delta H/\delta P)_T = 0$

(*b*) With the help of an Ellingham diagram, comment on the metallothermic reduction of metal oxide. 5 + 5

6. (*a*) The activities of Zn and Cd in an alloy at $N_{zn} = 0.4$ are 0.3 and 0.65 respectively at 500 K. Calculate the various properties of solution like ΔG^M, ΔG^M_{id} and ΔG^{XS}.

(*b*) Derive necessary equation for free energy change in the formation of an ideal solution. 5 + 5

7. (*a*) Discuss briefly the thermodynamics and kinetics involved in the formation of an activated complex.

(*b*) Outline the different kinetic steps involved in the reduction of hematite iron ore by CO gas. Comment on the rate controlling step also. 5 + 5

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

(*a*) Interfacial reaction kinetics

(*b*) Boundary layer thickness

(*c*) Gibbs-Duhem equation

(*d*) Positive and negative deviations from Raoult's law.
