Dr Vishal Singh 24/11/2023 (122)

(M)

NATIONAL INSTITUTE OF TECHNOLOGY, HAMIRPUR, H.P

Department of Materials Science and Engineering

End Term Examination
Materials Thermodynamics and Kinetics (MS-213)
Duration: 3 hrs ***Maximum Marks***: 50
Attempt all the following questions.

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1. Briefly explain/define <u>any *ten*</u> of the following terms/concepts with suitable examples, wherever required:-

   i. *Configurational Entropy and Thermal Entropy*
   ii. *Open, Closed and Isolated Systems*
   iii. *Extensive and Intensive Properties*
   iv. *Hess' Law of Thermochemistry*
   v. *Gibbs and Helmholtz Free Energies*
   vi. *Integral and Partial Molar Quantities*
   vii. *Activity and Activity Coefficient*
   viii. *Raoult's and Henry Laws*
   ix. *Excess Functions*
   x. *The Chemical Potential*
   xi. *Rate and Order of a Reaction*
   xii. *Activity and Fugacity*

   (10 Marks)

2. Give two statements of the second law of thermodynamics and prove that they are equivalent. ***(5 Marks)***

3. State Kirchhoff's law. For solid silver, the molar heat capacity at constant pressure is given by $C_p = 21.3 + (8.535\times10^{-3}T) + (1.506\times10^{5}T^{-2})$ *J/g.atm.* $^{\circ}K$. Find the quantity of heat required to raise the temperature of 1 g.atom of silver from 25°C to 900°C. ***(4 Marks)***

4. Derive Gibbs-Duhem equation. ***(4 Marks)***

5. Derive *Gibbs-Helmholtz equation.* ***(4 Marks)***

6. Derive expressions for the *specific reaction rate (k)* and *half-life* ($t_{0.5}$) for a first order reaction. It is known that the radioactive decay of uranium-238 is a first order reaction and the half-life for this reaction is 4.51×10^{9} years. Calculate the specific reaction rate for this reaction. How many days will it take 75 percent of a given amount uranium-238 to disappear? ***(5 Marks)***

7. Differentiate between ideal and regular solutions. Briefly discuss the properties, viz., volume change, heat of formation and entropy of formation of an ideal solution. ***(6 Marks)***

8. Write short notes on <u>*any three*</u> of the following: -
   (a) Clausisus Theorem: its statement and proof
   (b) The Method of Tangential Intercepts
   (c) Regular Solution Model
   (d) Collision Theory or Theory of Absolute Reaction Rates
   (e) Maxwell's Relations and Their Derivation

   (12 Marks)