(冶金及材料組)

國立成功大學八十學年度礦冶及材料科學研究所考試(普通熱力學 試題) 共 2 頁 第 1 頁

1. (a) What is a thermodynamically reversible process ?
   (b) Give an example for such a process. (15%)

2. (a) What is the third law of thermodynamics ?
   (b) Give an example representing application of this law.
   (c) Why is the absolute entropy of a glass at $0^{\circ}K$ nonzero ?

   (15%)

3. (a) What are the differences between thermodynamic heat and enthalpy ?
   (b) Why is "equilibrium" always talked about in thermodynamics ?
   (c) Why is it necessary to acquire both thermodynamic and kinetic knowledge in learning many transitional processes, such as solidification of a supercooled liquid metal ? (15%)

4. (a) Derive the TdS equation,

$$TdS = C_v dT + T\left(\frac{\partial P}{\partial T}\right)_v dV \quad , \quad \text{and}$$

   (b) from this TdS equation, derive the energy equation,

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_v - P$$

   (10%)

5. Derive that $\Delta G^{\circ} = -RT \ln K$, where K is the equilibrium constant for a chemical reaction

   $aA + bB + \ldots = rR + sS + \ldots$

   at constant pressure and temperature. A,B,... are reactants, R,S,... are products, and the prefixes are the number of g-atoms or g-molecules of the corresponding species. (10%)

6. Zinc melts at $420^{\circ}C$ and its standard entropy at $25^{\circ}C$ is 9.95 cal/deg/mole. Calculate the standard entropy of zinc at $750^{\circ}C$.

   Given: Heat of fusion of Zn at the melting point,

   ΔH_f = 1.74 kcal/mole

   Cp (solid Zn) = $5.35 + 2.40 \times 10^{-3} T$ cal/deg/mole

   Cp (liquid Zn) = 7.50 cal/deg/mole. (10%)

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7. ΔG° for the reaction

$$Ni + 1/2\ O_2 = NiO$$

at 25 °C is -50,786 cal. Calculate ΔG° at 327 °C from the following data :

$\Delta H^\circ_{298,NiO}$ = -57,500 cal/mole

$C_{p,Ni} = 6.03 + 10.44 \times 10^{-6} T^2 - 2.50 \times 10^{-3} T$ cal/deg/mole

$C_{p,O_2} = 7.16 + 1.0 \times 10^{-3} T - 0.4 \times 10^{5} T^{-2}$ cal/deg/mole

$C_{p,NiO} = 12.91$ cal/deg/mole. (10%)

8. The heat of melting of ice is 1436 cal/mole. What is the entropy change on melting at
(a) 0°C and 1 atm pressure ?
(b) 0 °C and 100 atm pressure ?
(c) -10 °C and 100 atm pressure ?

For water at 0 °C :

	Coeff. of Thermal Expansion (Volume)	Density	Cp
Solid	0.1521×10^{-3}/K	0.917 g/cm^3	0.500 cal/g/K
Liquid	-0.06427×10^{-3}/K	1.00 g/cm^3	1.00 cal/g/K

(15%)