

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°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%)

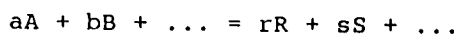
4. (a) Derive the TdS equation,

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

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

$$\left(\frac{\partial U}{\partial V} \right)_T = T \left(\frac{\partial P}{\partial T} \right)_V - P \quad (10\%)$$

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



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°C and its standard entropy at 25°C is 9.95 cal/deg/mole. Calculate the standard entropy of zinc at 750°C.

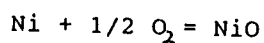
Given: Heat of fusion of Zn at the melting point,

$$\Delta H_f = 1.74 \text{ kcal/mole}$$

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

$$C_p (\text{liquid Zn}) = 7.50 \text{ cal/deg/mole.} \quad (10\%)$$

- 7.
- ΔG°
- for the reaction



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

$$\Delta H_{298, \text{NiO}}^\circ = -57,500 \text{ cal/mole}$$

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

$$C_{p, \text{O}_2} = 7.16 + 1.0 \times 10^{-3} T - 0.4 \times 10^{-5} T^2 \text{ cal/deg/mole}$$

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

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	$0.1521 \times 10^{-3}/\text{K}$	0.917 g/cm ³	0.500 cal/g/K
Liquid	$-0.06427 \times 10^{-3}/\text{K}$	1.00 g/cm ³	1.00 cal/g/K

(15%)