1. The ice of an outdoor skating rink is at the temperature of $-2.0\,℃$. Calculate the minimum pressure (applied for example by a skate) necessary to melt the ice. (20%)
   Data: At 0℃, the specific volume of water is 1.000 cm^3/g and that of ice is 1.090 cm^3/g; the heat of fusion is 79.7 cal/g.
   Unit conversions: 1 atm = 101325 N/m^2, 1 cal = 4.18 J

2. Show that the slope of β vs. T curve is horizontal at T = 0 K, i.e. $\left(\frac{\partial \beta}{\partial T}\right)_P = 0$ at T = 0 K. (20%)
   Where β = the coefficient of isothermal compressibility = $-\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$, T = temperature, V = volume, P = pressure

3. Al-Zn alloys exhibit the following relation at 477℃

$$RT \ln \gamma_{Zn} = 1750(1 - X_{Zn})^2$$

   Where R = 1.987 cal/mole K, and T is expressed in K. γ_{Zn} and X_{Zn} are, respectively, the activity coefficient and the molar fraction of Zn in the alloy. Calculate the activity of aluminum at 477℃ in an Al-Zn alloy containing 40 atom% zinc. (20%)

4. Nickel and element A are related by a phase diagram of the type shown in Figure 1. At 727℃, element A will dissolve 4 atom% nickel and nickel will dissolve 6 atom% A. Calculate the oxygen pressure at which nickel dissolved in A to the extent of 1 atom% will just begin to oxidize to NiO. Element A is more stable than nickel and will oxidize only at higher oxygen pressures. (20%)
   Given: the standard free energy for the reaction

$$NiO(s) = \frac{1}{2}O_2(g,\ 1\ atm) + Ni(s) \qquad \Delta G^0 = 146000\ J$$

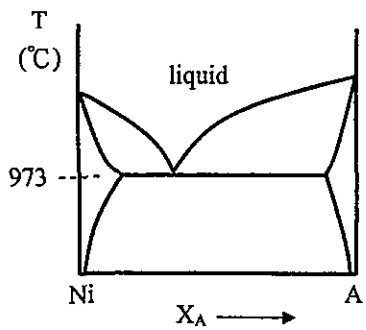

Figure 1

5. The molar free energy, G, of a regular solution composed of elements A and B can be expressed as

$$G = X_A G_A + X_B G_B + \Omega X_A X_B + RT(X_A \ln X_A + X_B \ln X_B)$$

   Where G_A and G_B are the molar free energy of pure A and B, respectively. X_A and X_B are the molar fraction of A and B in the solution. Ω is related to the difference between A-B bonds and (A-A bonds + B-B bonds).

(1) Show that $\frac{d^2G}{dX^2} = \frac{RT}{X_A X_B} - 2\Omega$, where X is X_A or X_B. (10%)

(2) Based on the equation shown in question 5.(1), what are the conditions under which the free energy curve (G vs. X_B plot) of a regular solution exhibits a maximum? (10%)

試題隨卷繳回