招生學年度	101	招生類別	碩士班
系所班別	材料科學與工程學系碩士班		
科目	冶金熱力學		
注意事項	本考科可使用掌上型計算機		

1. (a) Prove $\Delta H = \int C_p dT + \int V(1-\alpha T)dP$

(b) The molar volume of Fe is 7.1 cm^3. The expansivity of Fe is $0.3*10^{-4}$ K^{-1}. The increase pressure exerted on Fe from 1atm to 100 atm at 373 K. How much heat does the molar Fe increase? (8+7 points)

2. (a) Drive the Gibbs-Duhem equation. $X_1 d\overline{A_1} + X_2 d\overline{A_2} + ... = 0$

(b) Show that $\overline{A_1} = A + A_2 \frac{dA}{dX_1}$ and $\overline{A_2} = A + A_1 \frac{dA}{dX_2}$. (Hint: $X_1 + X_2 = 1$, $A = X_1\overline{A_1} + X_2\overline{A_2}$) (8+7 points)

3. Calculate the activity of FeO in a $FeO\text{-}Al_2O_3\text{-}SiO_2$ melt below which the FeO cannot be reduced to pure liquid iron by $CO\text{-}CO_2$ mixture of $P_{CO}/P_{CO2} = 10^7$ at 1700 °C.

$Fe_{(l)} + \frac{1}{2}O_{2(g)} = FeO_{(l)}, \Delta G^0 = -256000 + 53.68T$ (J); $C_{(s)} + \frac{1}{2}O_{2(g)} = CO_{(g)}, \Delta G^0 = -111700 - 87.65T$ (J)

$C_{(s)} + O_{2(g)} = CO_{2(g)}, \Delta G^0 = -394100 - 0.84T$ (J)　(10 points)

4. One mole of a monatomic ideal gas is subjected to the following 4 process.

a. Starting at 300 K and 10 atm, the gas expands by isothermal process to triple its volume.
b. The gas is next heated reversibly to 400 K at constant volume.
c. The gas is reversibly expanded at constant temperature until its volume is again tripled.
d. The gas is reversibly cooled to 300 K at constant pressure.

Calculate the values of q, w, and the changes in U, H, and S of each process and total process. (Unit: Joule) (25 points)

	q	w	ΔU	ΔH	ΔS
a	(a)	(b)	(c)	(d)	(e)
b	(f)	(g)	(h)	(i)	(j)
c	(k)	(l)	(m)	(n)	(o)
d	(p)	(q)	(r)	(s)	(t)
Total	(u)	(v)	(w)	(x)	(y)

5. Use Richardson-Ellingham chart for oxides to answer the following question:

(a) What is the dissociation oxygen pressure of FeO at 400 °C?

(b) What is the ratio of a H_2/H_2O gas mixture that can prevent the reduction of Cr_2O_3 at 200 °C?

(c) When ratio of the CO/CO_2 gas mixture is 10^3 at 500 °C, what is the ratio of the H_2/H_2O gas mixture the same as the CO/CO_2 gas mixture?

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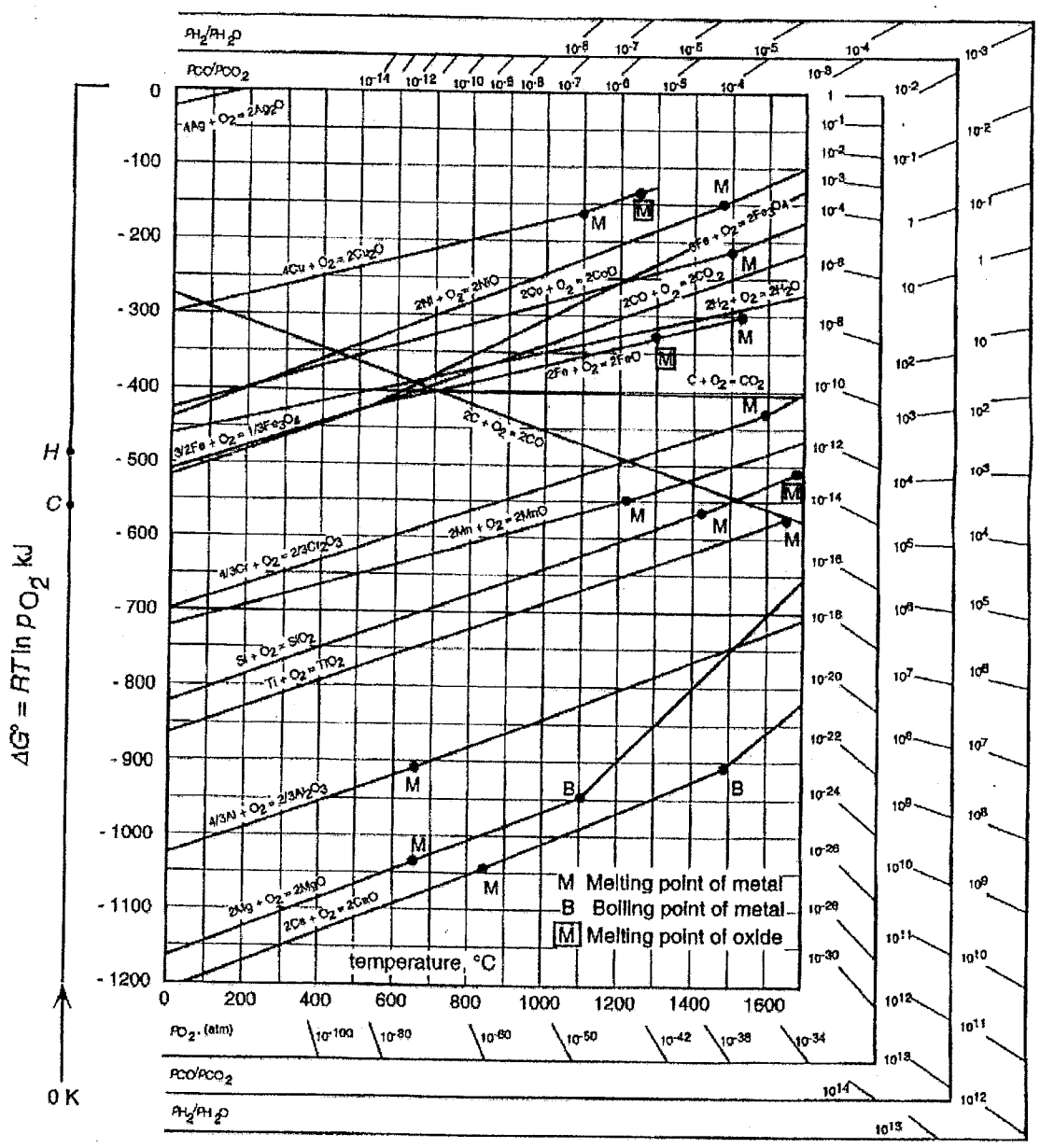
(d) What is the oxygen pressure in (c)?

(e) List the stability sequence of the oxides at 0 C°: CoO, Al_2O_3, Cu_2O, TiO_2, MgO, SiO_2, and NiO. (4+4+4+4+4 points)



6. (a) Derive van't Hoff equation from Gibbs-Helmholtz equation.

(Hint: Gibbs-Helmholtz equation: $\frac{\partial(G/T)}{\partial T} = -\frac{\Delta H^0}{T^2}$; van't Hoff equation: $\frac{\partial \ln K_p}{\partial T} = \frac{\Delta H^0}{RT^2}$.)

(b) The equilibrium constant for Al synthesis reaction is 775 at 25 °C based on 1 atm ideal gas standard state. The enthalpy change associated with the reaction (the heat of reaction) ΔH^0=-45.9 kJ. Determine the equilibrium constant at 100 °C. (5+10 points)