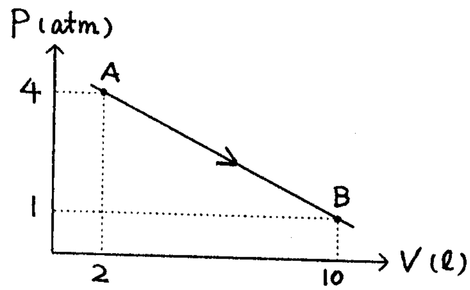
Physical constants which you may need:
gas constant R=8.314 J/mol-K=0.082 atm-l/mol-K
Boltzmann's constant $k=1.38\times10^{-23}$ J/K

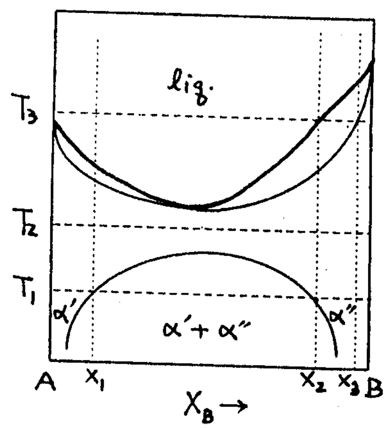
1. (24%) In order to relate the thermodynamic functions U, H and S to the independent variables T and P (temperature and pressure), please derive the following differential forms: (i) dU=MdT+NdP; (ii) dH=M'dT+N'dP; (iii) dS=M″dT+N″dP. [Note: you must express M, N, M', N', M″, N″ in terms of thermodynamic parameters T, P, V, c_p, α, and β. (where: $c_p = \left(\frac{\partial H}{\partial T}\right)_P$, $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$, $\beta = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$)].

2. (20%) For 1 mole of monatomic ideal gas under the process path from state A to state B (shown as right). Please calculate (a) δw (done by the gas); (b) δq (absorbed by the gas); (c) ΔU; (d) ΔS; (e) ΔH of the process.



3. (7%) Describe the thermodynamic characterization of first-order phase transition.

4. (15%) For a hypothetical binary phase diagram shown as right, please plot the Gibbs free energy - composition (ΔG^{mix}-X) diagrams for temperatures T_1, T_2 and T_3.



5. (6%) Point out which of the statement(s) is (or are) wrong and explain the reason why:
(a) During a reversible process, the entropy change of a system is zero.

(背面仍有題目,請繼續作答)

(b) During an irreversible process, the entropy change of a system is greater than zero.

(c) There is no such an engine that could fully convert heat from a single reservoir to work.

(d) Heat could be conducted from a high temperature reservoir to a low temperature reservoir without any loss of heat.

6. (12%) One mole of molten aluminum is adiabatically contained and supercooled to 10 K below its melting point (T_m=932K). Use the following data to find out (i) the amount of the aluminum which spontaneously freezes; (ii)the change of entropy by spontaneous freezing. DATA: $C_{p(s)}$ = 26 J/mol-K; $C_{p(liq)}$ = 29 J/mol-K; heat of melting (ΔH_m) = 10700 J/mol at T_m=932K.

7. (10%) Using the following data, determine the P_{H2}/P_{H2O} ratio to oxidizing silicon in water vapor ambient at 1400K.

DATA: $H_{2(g)} + 0.5\ O_{2(g)} \rightarrow H_2O_{(g)}$ $\Delta G^\circ = -246,000 + 54.8\ T$

$Si_{(s)} + O_{2(g)} \rightarrow SiO_{2(s)}$ $\Delta G^\circ = -907,100 + 175\ T$

8. (6%) Point out which of the statement(s) is (or are) wrong and explain the reason why:

(a) For an ideal solution of condensed phases, $a_i=X_i$ (activity of component i = mole fraction of component i).

(b) For a nonideal solution of condensed phases, $a_i=\gamma_i X_i$. And when $X_i \rightarrow 1$, $a_i \rightarrow 1$ and $\gamma_i \rightarrow 1$.

(c) For a binary regular solution, $ln\ \gamma_A=\alpha X_B^2$ and $\Delta H^M=\alpha RTX_AX_B$. Where α is independent of temperature and composition.

(d) The quasi-chemical model for regular solutions is more applicable at low temperatures than at high temperatures.