1. The partial pressure of mercury above an amalgam (alloy) of mercury (Hg) and thallium (Tl) is 43.3% of its value over pure mercury at the same temperature (325°C). The amalgam contains 50.3 mole% thallium. (20分)

a). Calculate the activity coeficient of the mercury in this solution.
b). What is the change in free energy in transfering 1 mole of mercury from an infinitely large quantity of this solution into pure mercury at the same temperature and pressure?

2. Zinc oxide can be reduced to elemental zinc by the reaction with carbon monoxide, as follow: (20分)

$$ZnO\,(S) + CO\,(g) \rightarrow Zn\,(g) + CO_2\,(g)$$

A mixture of one mole CO and $CO_2$ each, one mole Zn and 0.75 mole solide ZnO are equilibrated in a reaction vessel at 1500°K.

(a) what is the equilibrium composition of this gas mixture when the total pressure is 1 atm?

(b) At what pressure will all of the solid ZnO disappear?

Data:

| Compound | $G_0$(1500°K), kcal/gmole |
|---|---|
| ZnO (s) | -109.7 |
| CO (g) | -92.1 |
| CO2 (g) | -168.8 |
| Zn (g) | -32.6 |

*(You should also state all assumptions made in solving the problem.)*

3. The state function of enthalpy for a material may be described with a general equation: (20分)

$$dH = C_p\,dT + V(1-\beta T)\,dP.$$

and the following data are known for this material:

| T(°C) | P(atm) | V(cm)$^3$/gmole | β (°C)$^{-1}$ | $C_p$(cal)/(gmole °C) |
|---|---|---|---|---|
| 0 | 1 | 14.72 | 181 x10$^{-6}$ | 6.69 |
| 0 | 1000 | 14.67 | 174 x10$^{-6}$ | 6.69 |
| 100 | 1 | -- | -- | 6.57 |

Determine the *enthalpy change* of this material for a change of state from 1 atm and 100°C to 1000 atm and 0°C.

4. Suppose the transfomation of A to B occurs by both a reversible first-order reaction and a reversible second-order reaction involving hydrogen ion. (20分)

$$A \underset{k_2}{\overset{k_1}{\rightleftharpoons}} B \qquad A + H^+ \underset{k_4}{\overset{k_3}{\rightleftharpoons}} B + H^+$$

What is the relationship between these four rate constants ?

(背面仍有題目,請繼續作答)

5.

(a) Show that (20分)

$$(\partial U/\partial V)_T = \frac{\alpha T - \kappa P}{\kappa}$$

in which

$\alpha = (1/V)(\partial V/\partial T)_P$ , $\kappa = (-1/V)(\partial V/\partial P)_T$

(b) Calculate $(\partial U/\partial V)_T$ for a van der Waals gas.