國立臺灣科技大學
八十九學年度碩士班招生考試試題

系所組別： 工程技術研究所材料科技學程
科　目： 熱力學

總分 100 分

1. (20%)

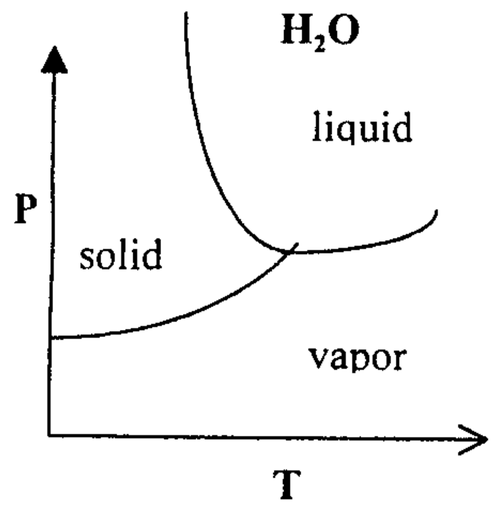
(a) (10%) Please describe the first law and the second law of thermodynamics.

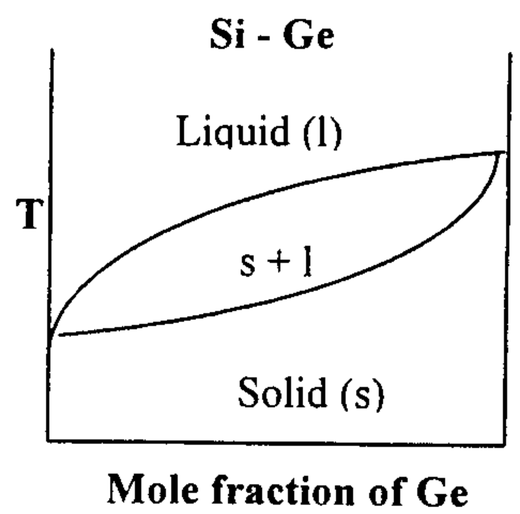
(b) (10%) From the first and the second laws of thermodynamics, please construct the energy criteria that can be used to determine whether a spontaneous reaction occurs at constant temperature (T) and pressure (P), and constant volume (V) and T, and constant P and entropy (S), and constant S and V, respectively.

2. (20%)

(a) (10%) What is the physical meaning of the Gibbs-Duhem equation?

(b) (10%) What is the Gibbs phase rule? According to the phase rule, please explain why the two-phase coexistence for a single component is a "curve"; while for binary component systems, the two-phase coexistence is a "region", as shown below.





3. (30%) A real gas is described by Van der Waals equation $\left(P+\frac{a}{v^2}\right)(v-b)=RT$, where P is pressure, v is molar volume, T is temperature, R is the gas constant, and a and b are positive constants. Below the critical point T_{cr}, the liquid and the gas phases can coexist.

(a) (7%) Please plot the corresponding P versus v at $T>T_{cr}$, $T=T_{cr}$, and $T<T_{cr}$, respectively.

(b) (10%) In the P-v curve for $T<T_{cr}$, please indicate the metastable, unstable, and stable states of this real gas. Justify your answers!

(c) (8%) Please plot the phase diagram in terms of P versus v. Inside the two-phase region, please also specify the metastable and unstable regions.

(d) (5%) Please plot the phase diagram in terms of P versus T.

4. (30%) For a regular solution of binary A and B mixtures, the mixing Gibbs free energy per mole, ΔG_m, is given by

$$\Delta G_m = RT(x_A \ln x_A + x_B \ln x_B) + \Omega x_A x_B$$

where R is the gas constant, T is the temperature, x_I is the mole fraction of component I, I =A, B, and Ω is the net interaction parameter between A and B.

(a) (6%) Please plot ΔG_m versus x_A at various Ω values.

(b) (7%) Is there any two-phase coexistence region for $\Omega \le 0$? Why?

(c) (8%) Is there any two-phase coexistence region for Ω very large? Why?

(d) (9%) Please plot the corresponding activity of component A, a_A, versus x_A for $\Omega<0$, $\Omega=0$, and $\Omega>0$, respectively.