國立臺灣海洋大學一００學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目： 冶金熱力學

系所名稱： 材料工程研究所碩士班甲組

※可使用計算器

1.答案以橫式由左至右書寫。2.請依題號順序作答。

（限用中文或英文作答；不須抄題目，亦不須按題目順序作答，但請註明題號！）

A. Some constants or known symbols;

(1) log 2 = 0.30; log 3 = 0.48; ln (x) = 2.3 log (x), where x > 0

(2) Gas constant (R) = 8.31 J/mol-K = 1.99 cal/mol-K = 0.08 liter-atm/mol-K

(3) U, H, G, S, P, V, T, D, C_p, and C_v represent the internal energy, enthalpy, Gibbs free energy, entropy, pressure, volume, temperature, density, heat capacity at constant pressure, and heat capacity at constant volume, respectively.

B. Questions

I. Single Selection (單選題；每題 5 分，答錯倒扣 2 分，不答得 0 分)

1. The state function is a variable which is independent of the path taken by the system between the two states. Which of the following variable is a state function? (a) U, (b) heat [q], (c) work [w], (d) V, (e) C_v.

2. The work done by a mole of an ideal gas when it is isothermally compressed from 20 m^3 to 5 m^3 at 300K is about (a) 1720.1, (b) -1720.1, (c) -3440.3, (d) -5160.3, (e) 7648.9 (joules).

3. The cracking of ammonia gas at 500K according to the reaction;
$2\,NH_{3\,(g)} = N_{2(g)} + 3\,H_{2\,(g)}$, and the Gibbs free energy (ΔG^o) of the reaction is equal to 12233.4 – 31.7T (joules)
Under the condition of constant total pressure, the final partial pressure of ammonia is close to (a) 0.03 (b) 0.25 (c) 0.50, (d) 0.75, (e) 0.98 (atm).

4. Which of the following Maxwell's relation is **incorrect**? (a) $(\frac{\partial T}{\partial V})_S = -(\frac{\partial P}{\partial S})_V$; (b) $(\frac{\partial C_p}{\partial P})_T = -T(\frac{\partial^2 V}{\partial T^2})_P$; (c) $(\frac{\partial S}{\partial V})_T = (\frac{\partial P}{\partial T})_V$; (d) $(\frac{\partial U}{\partial V})_T = -T(\frac{\partial P}{\partial T})_V + P$; (e) $C_p - C_v = T(\frac{\partial P}{\partial T})_V(\frac{\partial V}{\partial T})_P$.

II. Multiple Selection (複選題；每題 10 分，每答對一個答案得 2 分，每答錯一個答案倒扣 2 分，不答得 0 分)

1. Extensive variables are properties, the magnitudes of which depend on the size of the system, however, intensive properties are variables whose magnitude are independent of the size of the system. Which of the following variables are belonging to "**intensive properties**"? (a) T, (b) V, (c) U, (d) P, (e) H, (f) D, (g) S.

2. Ellingham diagram is a useful tool to estimate the oxidation of pure metal (M) under phase changes at various atmospheres and temperature. An example of the effects of phase changes of the metal M and its oxide (MO_2) of a reaction is shown in Fig. 1. Which of the following statements are **incorrect**?
(a) The oxidation of M is always an endothermic process;
(b) The Ellingham line for the oxidation of liquid M to form solid oxide (MO_2) has a great slope than the corresponding line for the oxidation of solid M;
(c) The melting temperature of M is expected to be lower than that of MO_2;
(d) At the melting point of M, the Gibbs free energy of M in solid state is equal to that in liquid state;
(e) The Ellingham line has an elbow downwards when M melts;

(f) The Ellingham line has an elbow upwards when MO_2 melts;
(g) The enthalpy of a high-temperature phase exceeds that of a lower-temperature phase by the latent heat of the phase.

3. The part of the phase diagram of water is schematically shown in Fig. 2. Based on your knowledge of thermodynamics, Which of the following statements are **correct**?
(a) There are three homogeneous regions in this diagram, consisting of liquid, solid, and vapor, respectively;
(b) The line of BO represents one of the heterogeneous systems coexisting ice and vapor water;
(c) In all the two-phase heterogeneous systems, the pressure of each system increases with increasing temperature
(d) If a quantity of pure H_2O is at some P and T which is represented by a point within the areas COA, the equilibrium state of pure H_2O is a liquid
(e) All the two-phase heterogeneous systems meet at the point O, the triple point, which represents the unique values of P and T;
(f) The path "amb" indicates that a quantity of solid ice is heated at a pressure of 1 atm, and melting occurs at the state m, and boiling occurs at the state of b;
(g) The phase boundary between the two phases of ice and water is that very thin region across which the density change abruptly from the value for homogeneous ice to the higher value for liquid water on the line AO.

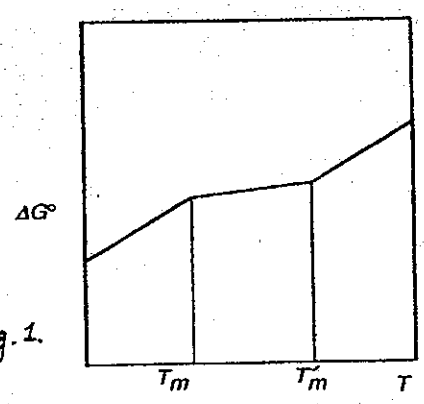

Fig. 1.

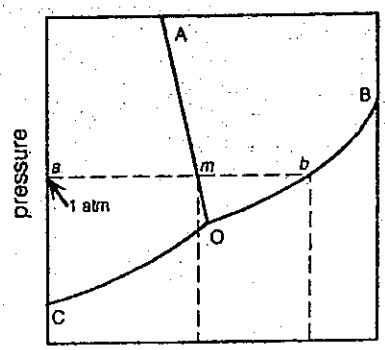

Fig. 2.

III. 問答題與計算題

1. (total 8%)

How to construct an atmosphere containing $P_{O_2} = 10^{-20}$ atm?

2. (total 30%)

(a) Derive the Clausius-Clapeyron equation.

The vapor pressure of solid zinc varies with temperature as

$$\ln p(\text{atm}) = -\frac{15775}{T} - 0.755 \ln T + 19.25$$

and the vapor pressure of liquid zinc varies with temperature as

$$\ln p(\text{atm}) = -\frac{15246}{T} - 1.255 \ln T + 21.79$$

Calculate :

(b) The normal boiling temperature of liquid zinc under 1 atm pressure

(c) The triple-point temperature

(d) The heat of evaporation of zinc at the normal boiling temperature

(e) The heat of fusion of zinc at the triple point

3. (total 12%)

(a) Derive the Gibbs-Helmholtz equation.

(b) If the thermodynamic data for one reaction :

T(K)	ΔG°(J/mole of NH_3)
298	−16,700
400	−6,700
500	5,000
600	15,500
700	26,600

Is the reaction exothermic or endothermic? Compute ΔH°.