國立臺灣科技大學
113學年度碩士班招生
試題

系所組別：0430材料科學與工程系碩士班丙組

科　　目：熱力學

<<504302>>

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(總分為 100 分；所有試題務必於答案卷內頁依序作答)

1. (17%) A mixture of Al and Fe_2O_3 follows the thermal reaction and this reaction is allowed to process to completion.

$$a\cdot Al + b\cdot Fe_2O_3 = c\cdot Fe + d\cdot Al_2O_3$$

(1) (4 %)Please determine the stoichiometric numbers: a, b, c and d.

(2) (8%) If this reaction is placed in the adiabatic container at 2000 K, please illustrate the diagram of relationship of H and T,

(3) (5%)Express ΔH(2000).

The melting points of Fe_2O_3 and Al_2O_3 are at 1566 and 2054°C, respectively. **You can assume any parameters to answer this question.**

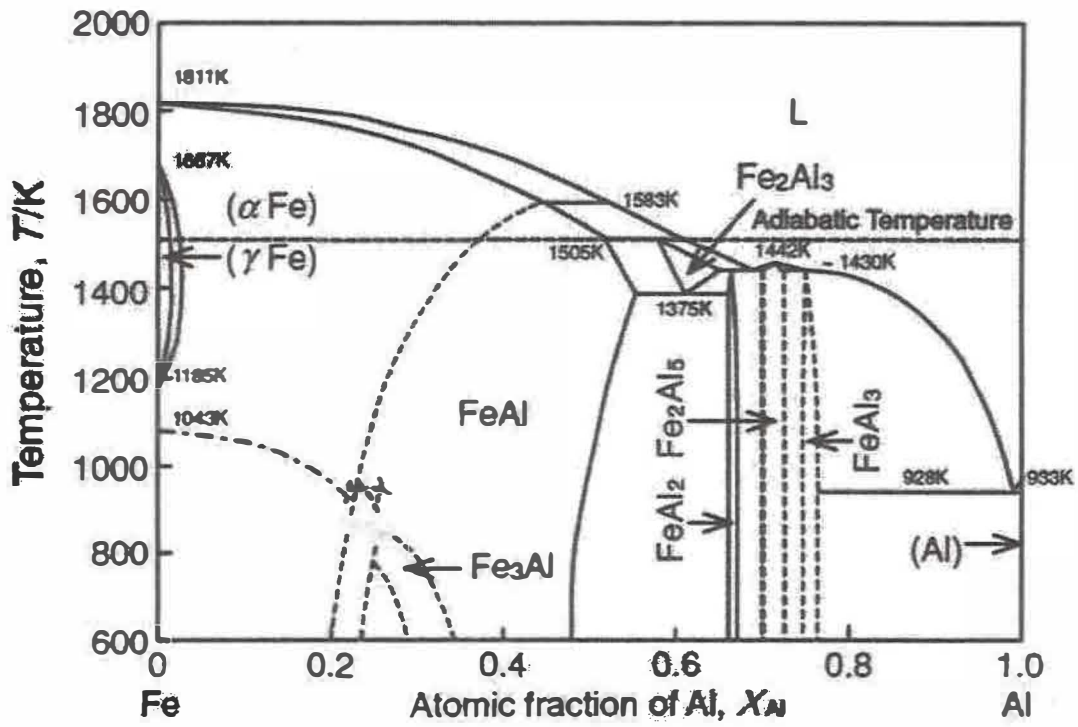

Fig.1 Fe-Al phase digram.

2. (15 %) Three allotropes α, β, and γ of certain element are in equilibrium at this trip point (Fig. 2). It is known that

$$V^{\gamma} < V^{\alpha} \text{ and } S^{\gamma} < S^{\beta}$$

Determine which regions of the diagram are α, β and γ. Explain your reason.

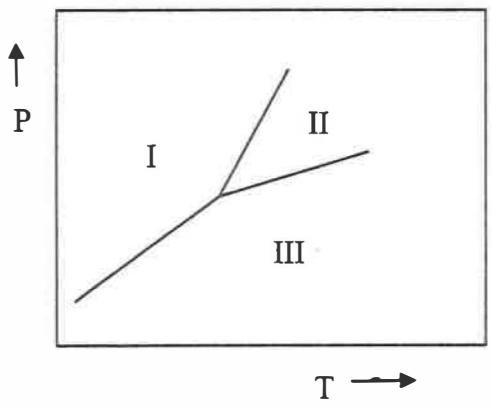

Fig. 2 P-T diagram for a one-component system in the vicinity of its triple point.

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(總分為100分；所有試題務必於答案卷內頁依序作答)

3. (18%) The P-V diagram of the Air-standard Diesel engine is illustrated in Fig. 3. In step, DA, heat is absorbed by air at constant pressure. Then the air is expanded adiabatically and reversibly (step AB), cooled down at constant volume (step BC), and finally compressed adiabatically and reversibly to the initial state at D. Please drive an equation giving the thermal efficiency of this cycle in relation to the compression ratio r (ratio of volumes at the beginning and the end of the compression step) and the expansion ratio r_e (ratio of volumes at the end and beginning of the expansion step).
You can assume any parameters to answer this question.

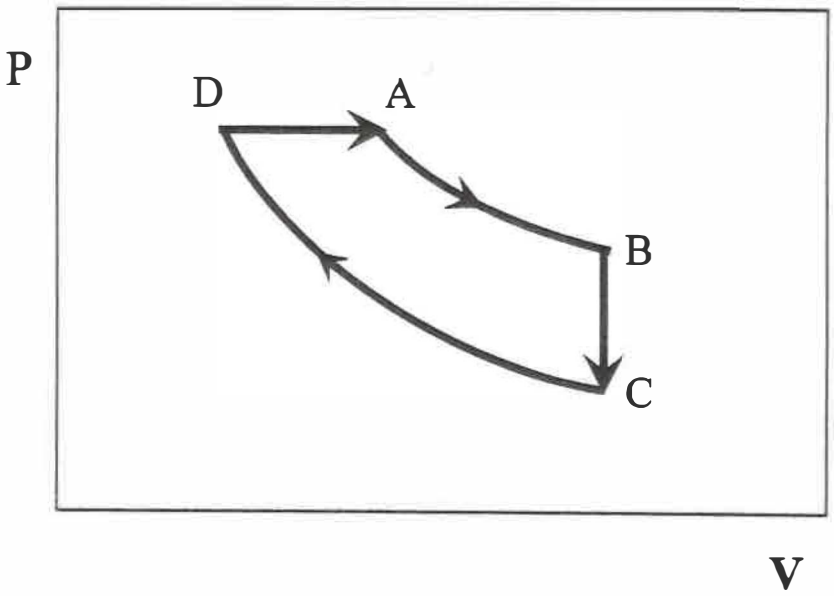

Fig. 3 An air-standard Diesel cycle.

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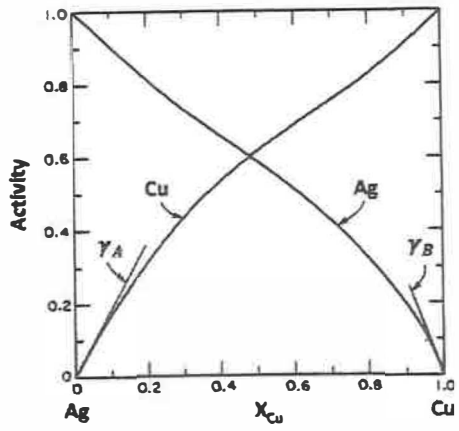
(總分為 100 分；所有試題務必於答案卷內頁依序作答)

4. **(30%)** The figure shows the activity vs. molar fraction of Cu (X_{Cu}) of Ag-Cu binary liquid solution at 1600°C. Answer the following questions.

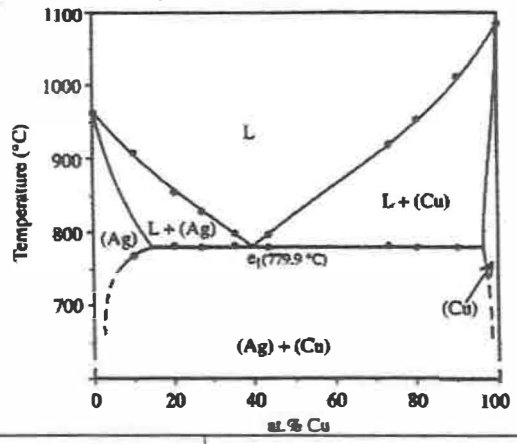


(1) **(5%)** Is the Ag-Cu binary liquid solution a positive or negative deviation solution?

(2) **(10%)** Assume that the Ag-Cu binary liquid solution obeys Henry's law in a dilute solution of Ag and Cu. Calculate the Henrian activity coefficients of γ_A and γ_B, and point out the Henrian activity coefficient of either Ag or Cu.

(3) **(15%)** The Ag-Cu binary liquid solution consists of 1 mole Ag and 99 mole Cu. Calculate the change in molar Gibbs free energy of mixing (ΔG^M), the change in partial molar enthalpy of Cu ($\Delta \bar{H}_{Cu}^M$), and the change in the partial molar entropy of Cu ($\Delta \bar{S}_{Cu}^M$).

5. **(20%)** The figure shows the Ag-Cu phase diagram with the change in the atomic percentage of Cu. Some thermodynamic properties of Ag and Cu are given in the table.



	T_m (°C)	ΔH_m^0 ($J\ mol^{-1}$)	C_P ($J\ mol^{-1}\ K^{-1}$) $= a + bT + cT^{-2}$		
			a	$b \times 10^3$	$c \times 10^{-5}$
$Ag_{(l)}$	962	11090	30.50	---	---
$Cu_{(l)}$	1085	12970	23.96	---	---
$Cu_{(s)}$			30.29	-10.71	-3.22

The Ag-Cu binary liquid solution forms the regular solution at 1600°C of the eutectic composition, showing the relation of:

$$\ln \gamma_{Cu} = 0.65 X_{Ag}^2$$

A crucible contains liquid Ag at 1600°C, and then a solid Cu at 27°C is added to the liquid Ag, forming the 1 mole of eutectic mixture. The crucible temperature is always 1600°C.

(1) (10%) Calculate the change in total enthalpy in the overall process.

(2) (10%) Calculate the change in total entropy in the overall process.