# 國立臺灣科技大學

## 115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. (20%) Three allotropes α, β, and γ of certain element are in equilibrium at this trip point (Fig. 1). 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.

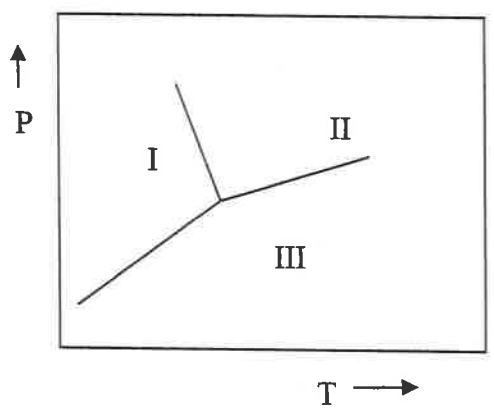


Fig. 1 Schematic pressure–temperature phase diagram for a one-component system in the vicinity of its triple point. All phase are solids.

2. (20%) Please define the following technical terms and provide illustrative diagrams.
(a) (10%) metastable; (b) (10%) Invariant reaction in the phase diagram.

3. (5%) If ΔU= Q-W, Work done by a system is taken to be,
   a) positive
   b) negative
   c) zero
   d) varies according to situation

4. (5%) Entropy may decrease locally at some region within the isolated system. How can this statement be justified?
   a) this cannot be possible
   b) this is possible because entropy of an isolated system can decrease.
   c) it must be compensated by a greater increase of entropy somewhere within the system.
   d) none of the mentioned

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5. (50%) Multiple choice questions (multiple answers) [**No score for incomplete answers**]

(1) (10%) What are true about a binary system with positive deviation from ideality?

A. The magnitude of the bond energy between like atoms is greater than that between unlike atoms.

B. The integral molar enthalpy of mixing is positive, implying an endothermic mixing process.

C. During solidification, the system tends to form long-range ordered superlattices and stable intermetallic compounds.

D. The observed eutectic temperature is higher than that predicted by the ideal solution model.

(2) (10%) What are true about an oxidation reaction that is endothermic and exhibits a decrease in entropy?

A. The slope of the Ellingham line is positive.

B. The intercept at 0K in the Ellingham diagram is positive.

C. The reaction is non-spontaneous under standard conditions at all temperatures.

D. The equilibrium constant ($K$) is larger than that of a typical exothermic oxidation reaction at the same temperature.

(3) (10%) Which of the following expressions are valid **ONLY** for an ideal solution? (Symbols: $Y$: integral thermodynamic properties; $\overline{Y_i}$: partial molar properties of pure substance $i$; $Y_i^0$: molar property of pure substance $i$)

A. $V = \sum X_i \overline{V_i}$

B. $V = \sum X_i V_i^0$

C. $H = \sum X_i \overline{H_i}$

D. $H = \sum X_i H_i^0$

E. $G = \sum X_i \overline{G_i}$

F. $G = \sum X_i G_i^0$

(4) (10%) What are true about the phase equilibrium in a binary system?

A. At equilibrium under constant temperature and pressure, the chemical potential of each component must be equal across all coexisting phases.

B. At equilibrium under constant temperature and pressure, the molar fraction of each component must be equal across all coexisting phases.

C. A binary eutectic reaction under constant pressure is an invariant equilibrium with 0 degrees of freedom.

D. In a binary two-phase region under constant temperature and pressure, the system has 1 degree of freedom, allowing phase compositions to

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vary freely.

(5) (10%) What are true about a binary system with sub-regular solution behavior?

A. The sub-regular nature results in an asymmetric miscibility gap and spinodal curve, meaning the critical composition is not at $X = 0.5$.

B. The critical temperature is determined by the conditions where the first and second derivatives of Gibbs free energy vanish (i.e., $\partial G/\partial X = 0$ and $\partial^2 G/\partial X^2 = 0$).

C. Within the spinodal region ($\partial^2 G/\partial X^2 < 0$), the diffusion coefficient is negative, leading to spontaneous uphill diffusion.

D. Phase separation occurs when the operating temperature is above the critical temperature.