

國立臺灣科技大學

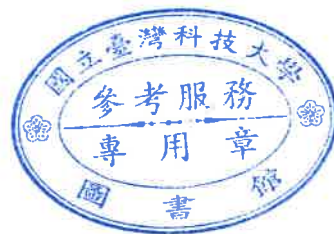
114學年度碩士班招生

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. (50%): Multiple-choice questions, 5 points per question.

(1) (5%) For an irreversible process,

- a) $dS = dQ/T$
- b) $dS > dQ/T$
- c) $dS < dQ/T$
- d) none of the mentioned

(2) (5%) Which of the following relation is correct?

- a) $dU = TdS - PdV$
- b) $dH = TdS + VdP$
- c) $dG = VdP - SdT$
- d) all of the mentioned

(3) (5%) Efficiency of a heat engine is defined as

- a) total heat output / net work input
- b) total heat input / net work output
- c) net work output / total heat input
- d) net work input / total heat output

(4) (5%) The ____ in entropy in an irreversible change is a measure of the extent to which energy ____ in that change.

- a) decrease, degrades
- b) increase, degrades
- c) increase, increases
- d) decrease, increases

(5) (5%) A real gas behaves as an ideal gas when?

- a) Temperature approaches zero
- b) Pressure approaches zero
- c) Both temperature and pressure approaches zero
- d) None of the mentioned

(6) (5%) Clausius summarized the first and second laws of thermodynamics as

- a) the energy of the world is constant
- b) the entropy of the world tends towards a maximum
- c) both of the mentioned
- d) none of the mentioned

(7) (5%) Work done by a system is taken to be ____, if the 1st Law is described by $\Delta U = Q - W$

- a) positive
- b) negative
- c) zero
- d) varies according to situation



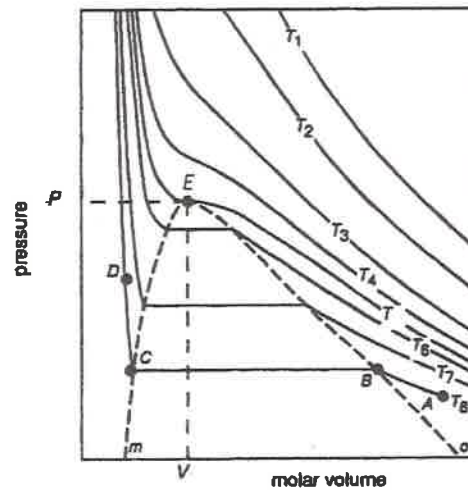
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- (8) (5%) According to Joule's experiments,
- heat can be completely converted into work
 - work can be completely converted into heat
 - both heat and work are completely interchangeable
 - all of the mentioned
- (9) (5%) Fig. 1 shows the P-V diagram for the ideal gas system, the critical point in Fig. 1 is
- A
 - C
 - B
 - E



P-V isotherms for a typical real gas.

Fig. 1

- (10) (5%) Fig.2 shows the phase diagram of the Ag-Cu system, Which of the following is correct?
- Ag-Cu system is the eutectic system
 - The melting point of Ag is 1084.87°C
 - The eutectic composition is Ag-28.1 wt.%Cu
 - The eutectic composition is Ag-28.1 at.%Cu

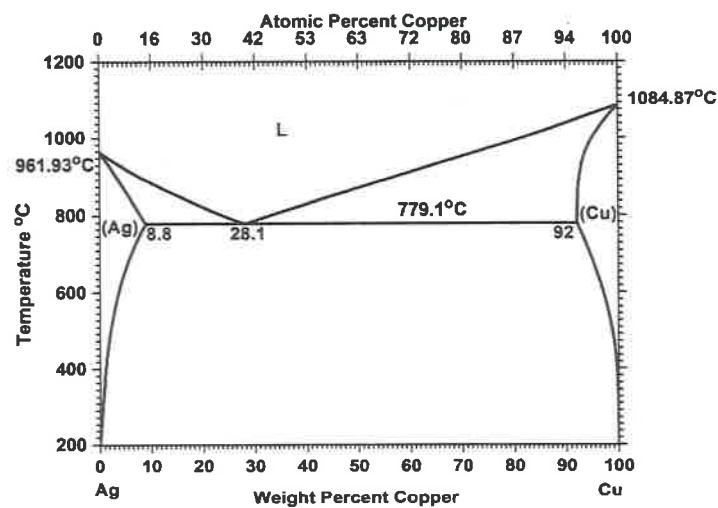


Fig. 2



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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)

2. (35%) During the Warring States period, bronze weapons were crafted from a 93% Cu - 7% Sn (atomic percentage) alloy through a three-step process: mixing at 1320°C of liquid solution, controlled cooling to 727°C of solid solution where a stable α -Cu single phase formed, and rapid cooling to room temperature to achieve a metastable supersaturated α -Cu phase. This process yielded bronze with superior strength, hardness, ductility, and corrosion resistance.

The activity coefficient of Sn at 1320°C in the liquid solution is:

$$\ln \gamma_{Sn} = -5.394X_{Cu}^2 + 2.496 \quad (0 < X_{Sn} < 0.2)$$

The enthalpy change of mixing at 727°C in the solid solution is:

$$\Delta H^M (J \text{ mol}^{-1}) = -47001X_{Sn}^3 + 82333X_{Sn}^2 - 35763X_{Sn}$$

The melting points of Cu and Sn are 1085°C and 232°C, respectively. The specific heat capacities of solid and liquid Cu are 24.4 and 31.4 J mol⁻¹ K⁻¹, respectively. The specific heat capacities of solid and liquid Sn are 27.1 and 32.1 J mol⁻¹ K⁻¹, respectively.

Answer the below questions based on a 1 mole of 93% Cu - 7% Sn (atomic percentage) alloy.

- (1) (5%) Is the liquid solution at 1320°C a positive or negative deviation from the Raoultian solution?
- (2) (5%) Express the activity coefficient of Cu at 1320°C in the liquid solution.
- (3) (5%) Calculate Sn's activity coefficient and activity at 1320°C in the liquid solution.
- (4) (5%) Calculate Cu's activity coefficient and activity at 1320°C in the liquid solution.
- (5) (5%) Calculate the Gibbs free energy change of mixing at 1320°C in the liquid solution.
- (6) (10%) Calculate the total enthalpy change of mixing from 1320°C of liquid solution to 727°C in the solid solution

3. (15%) Cupronickel is an important copper-nickel alloy, primarily composed of 70-90% copper (Cu) and 10-30% nickel (Ni). This alloy possesses excellent physical and chemical properties, including good thermal and electrical conductivity, superior corrosion resistance (particularly against seawater), and outstanding workability.

The cupronickel is a solid and regular solution at 1373 K, followed by:

$$\ln \gamma_{Ni} = 0.333X_{Cu}^2$$

Answer the below questions based on a 1 mole of 90% Cu - 10% Ni (atomic percentage) alloy.

- (7) (5%) Calculate the Gibbs free energy change of mixing at 1373 K.
- (8) (5%) Calculate the entropy change of mixing at 1373 K.
- (9) (5%) Calculate the enthalpy change of mixing at 1373 K.

