

國立成功大學

115學年度碩士班招生考試試題

編 號：61

系 所：資源工程學系

科 目：熱力學

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節 次：第 2 節

注 意：1. 不可使用計算機
2. 請於答案卷(卡)作答，於
試題上作答，不予計分。

Part I. Multiple-Choice Questions (60%)

Each question is worth 3% for a correct answer, -1% for an incorrect answer, and 0% for no response.

1. Which pair of thermodynamic variables are typically considered intensive variables? A) Volume and Mass. B) Temperature and Pressure. C) Entropy and Internal Energy. D) Volume and Temperature.
2. The Zeroth Law of Thermodynamics introduces which fundamental concept? A) Internal energy, U . B) Entropy, S . C) Absolute temperature, T . D) Conservation of energy.
3. The enthalpy (H) of a closed system is defined generally as: A) $H=U-PV$. B) $H=U+PV$. C) $H=U-TS$. D) $H=TdS+VdP$.
4. For one mole of an ideal gas, the relationship between constant-pressure (C_p) and constant-volume (C_v) molar heat capacities is: A) $C_v/C_p=\gamma$. B) $C_p-C_v=R$. C) $C_v/C_p=R$. D) $C_p=(C_v/T)dT$.
5. For an irreversible process in a system, the total change in entropy of the universe (ΔS_{total}) must satisfy: A) $\Delta S_{total}=0$. B) $\Delta S_{total}>0$. C) $\Delta S_{total}\leq 0$. D) ΔS_{total} is independent of irreversibility.
6. The thermodynamic criterion for equilibrium in an isolated system (constant U , V) is that: A) Gibbs free energy (G) is minimized. B) Entropy (S) is maximized. C) Helmholtz free energy (A) is minimized. D) Work output is maximized.
7. The combined statement of the First and Second Laws for a closed simple system doing only P - V work is: A) $dU=TdS+PdV$. B) $dG=-SdT+VdP$. C) $dU=TdS-PdV$. D) $dH=TdS+VdP$.
8. Which thermodynamic potential is the natural dependent variable when Temperature (T) and Pressure (P) are chosen as the independent variables for a closed system? A) Internal Energy (U). B) Enthalpy (H). C) Helmholtz Free Energy (A). D) Gibbs Free Energy (G).
9. The Helmholtz free energy (A) provides the criterion for equilibrium in a closed system under which set of conditions? A) Constant T and P . B) Constant S and V . C) Constant T and V . D) Constant H and P .
10. The Maxwell relation derived from the exact differential $dG=-SdT+VdP$ is: A) $(\partial S/\partial P)_T=(\partial V/\partial T)_P$. B) $(\partial S/\partial V)_T=(\partial P/\partial T)_V$. C) $(\partial T/\partial P)_S=(\partial V/\partial S)_P$. D) $(\partial T/\partial V)_S=(\partial P/\partial S)_V$.
11. For a single-component system at constant pressure, the slope of the molar Gibbs free energy (G) versus temperature (T) curve is equal to: A) $-C_p/T$. B) $-S$. C) V . D) $\Delta H/T$.
12. The Clapeyron equation gives the slope of a two-phase coexistence curve in the P - T diagram. The equation is: A) $d\ln P/dT=\Delta H/RT^2$. B) $dP/dT=\Delta H/(T\Delta V)$. C) $dP/dT=\Delta V/(T\Delta H)$. D) $dG=-SdT+VdP$.
13. According to the Gibbs Phase Rule for a single-component system, if three phases ($\Phi=3$) coexist in equilibrium, the number of thermodynamic degrees of freedom (F) is: A) $F=3$. B) $F=2$. C) $F=1$. D) $F=0$.
14. The Law of Corresponding States implies that the compressibility factor (Z) for all real gases is approximately the same function of which generalized variables? A) Pressure P and Volume V . B) Internal Energy U and Enthalpy H . C) Reduced Temperature T_R and Reduced Pressure P_R . D) Critical Volume V_{cr} and Critical Pressure P_{cr} .
15. What is the integral enthalpy of mixing (ΔH_{mix}) for a mixture of ideal gases? A) Positive, as mixing is spontaneous. B) Negative, due to configurational energy release. C) Zero, as ideal gas particles do not interact. D) Dependent on the temperature.
16. A binary solution that exhibits negative deviations from Raoultian behavior ($\gamma_i<1$) generally has an integral enthalpy of mixing (ΔH_{mix}) that is: A) Positive (Endothermic mixing). B) Negative (Exothermic mixing). C) Zero (Ideal mixing). D) Unrelated to γ_i .
17. In a regular solution, the excess molar Gibbs free energy (G^{XS}) is equal to the: A) Change in volume of mixing (ΔV_{mix}). B) Change in entropy of mixing (ΔS_{mix}). C) Enthalpy of mixing (ΔH_{mix}). D) Work of volume expansion ($P\Delta V$).

18. The fundamental thermodynamic criterion that dictates the equilibrium state of a binary system at constant temperature (T) and pressure (P) is the minimization of the: A) Total enthalpy of the system. B) Total Gibbs free energy of the system. C) Total entropy of the system. D) Total configurational entropy.
19. In a binary phase diagram, the compositions of two coexisting phases (α and β) in equilibrium at a specific temperature are identified on the Gibbs free energy–composition diagram by: A) The point where $G^\alpha = G^\beta$. B) The intersection of the two G curves. C) The common tangent drawn between the two G curves. D) The composition where G is maximized.
20. For a symmetrical binary regular solution, phase separation (a miscibility gap) becomes thermodynamically imminent (the critical temperature is reached) when the ratio a/RT reaches the critical value of: A) 1. B) 2. C) 4. D) 8.

Part II. Essay Questions (40%)

1. One mole of an Fe–Ni alloy containing 50 at% Ni has Fe and Ni atoms randomly distributed on a body-centered cubic lattice. Derive the alloy's configurational entropy in terms of the mole fractions X_{Fe} and X_{Ni} , starting from the atom counts n_{Fe} and n_{Ni} . (15%)
2. One mole of an ideal gas undergoes an isothermal expansion in which its volume doubles. Calculate the resulting changes in the Gibbs free energy (10%) and the entropy (5%) of the gas.
3. Based on the provided phase diagram, consider the system at temperature T_1 .
- A) Plot the curve of the first derivative of the Gibbs free energy with respect to composition, $(\partial G/\partial c)_{T_1}$, versus composition c , and clearly mark the corresponding positions of compositions a, b, d, and e on the plot. (5%)
- B) Plot the curve of the second derivative of the Gibbs free energy with respect to composition, $(\partial^2 G/\partial c^2)_{T_1}$, versus composition c , and clearly mark the corresponding positions of compositions a, b, d, and e on the plot. (5%)

