

# 淡江大學 98 學年度碩士班招生考試試題

准帶計算機

系別：化學學系(化學組)

科目：物 理 化 學

本試題共 1 頁， 7 大題

1. Define the following terms. (27%)
  - (a) A state function of thermodynamics
  - (b) Chemical potential
  - (c) The law of corresponding states
  - (d) Second-order phase transition
  - (e) Carnot's principle
  - (f) Degree of degeneracy
  - (g) Spin-orbital
  - (h) A fermion and a boson
  - (i) Arrhenius equation
  
2. (a) Describe the **Joule experiment** for the **internal pressure measurement** of a non-ideal gas. (10%)
  - (b) Derive the **entropy change**  $\Delta S$  in terms of the experimental variables in (a). (5%)

Indicate all the symbols used in your answer.
  
3. Answer questions for the following reaction involving ideal gases A and B.
 
$$A_{(g)} \rightleftharpoons 2B_{(g)}$$
  - (a) With the known relation,  $\Delta G^\circ = -RT \ln K_p^\circ$ , derive the rate of change of  $\ln K_p^\circ$  with respect to the change of T in terms of  $\Delta H^\circ$ , T, and gas constant. (8%)
  - (b) Find  $K_p^\circ$  at 600 K for the above reaction assuming that  $\Delta H^\circ$  is independent of T. For the reaction at 298 K,  $\Delta H^\circ = 57.20 \text{ kJ/mol}$  and  $\Delta G^\circ = 4730 \text{ J/mol}$ . (7%)
  
4. (a) Draw the **300°C isotherm** of  $H_2O$  involving a **vapor-liquid phase transition** on a pressure versus molar volume (P- $V_m$ ) plot. (5%)
  - (b) Indicate the **molar volume change** for the condensation process on the plot. (2%)
  - (c) Draw the **critical temperature isotherm** on the plot. (3%)
  
5. (a) In quantum mechanics, the state of a system is defined by the state function  $\Psi$ . For an **n-particle system**, write down the equation governing how  $\Psi$  changes with time t. Define all the terms in the equation. (7%)
  - (b) Suppose a one-particle system has the state function  $\Psi(x, y, z, t')$  at time  $t'$ , write the expression of the **probability** of finding the particle in a infinitesimal region located at point  $(x_a, y_a, z_a)$  in space and having edges  $dx$ ,  $dy$ , and  $dz$ . (3%)
  
6. Write the expression for **dipole moment calculation** of a molecule from its **equilibrium-geometry electronic wave function**  $\phi$ . Define and explain each term in the expression. (8%)
  
7. For a chemical reaction of the form:  $aA \longrightarrow \text{products}$ , the reaction is first order in A.
  - (a) Derive the **integrated rate law** and the **reaction half-life** of A. Define all the necessary terms in your derivation. (10%)
  - (b) According to the results in (a), design an experiment to determine the **rate constant**. (5%)