

淡江大學 99 學年度轉學生招生考試試題

系別：化學工程與材料工程學系三年級 科目：物理化學

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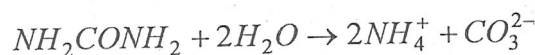
1. One mol of air is compressed from an ideal state of 1 bar and 25°C to a final state of 5 bar and 25°C by three different mechanically reversible processes in a closed system:
- Heating at constant volume followed by cooling at constant pressure.
 - Isothermal compression.
 - Adiabatic compression followed by cooling at constant volume.
- Assume air to be an ideal gas with the constant heat capacity, $C_V = (5/2)R$ and $C_P = (7/2)R$, in which R is gas constant and $R = 8.314 \text{ J/mol}\cdot\text{K}$. Calculate the work required, heat transferred, and the changes in internal energy and enthalpy of the air for each process. (30 points)

2. An ideal gas with constant heat capacities, C_V and C_P , undergoing a reversible adiabatic process from State 1 of T_1 and P_1 to State 2 of T_2 and P_2 . Prove that

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}}$$

where $\gamma = C_P/C_V$. (20 points)

3. The decomposition of urea in 0.1 M HCl occurs according to the reaction



The first-order rate constant for this reaction was measured as a function of temperature, with the following results:

Exp. No.	Temperature (°C)	Rate constant k (min^{-1})
1	61.0	7.13×10^{-6}
2	71.2	2.77×10^{-5}

Calculate the activation energy and derive an expression of the rate constant as function of temperature. (30 points)

4. The eigenvalue solutions of Schrödinger equation can be expressed as

$$E_n = \frac{h^2 n^2}{8ma^2}$$

Where h is Planck's constant ($6.626 \times 10^{-34} \text{ J s}$), n is the quantum number, m is the rest mass of electron ($9.11 \times 10^{-31} \text{ kg}$), and a is the dimension of box.

- (a) Calculate the energies of the two states of lowest energy for an electron in a one-dimensional box of

length 2.0 \AA . (10 points)

(b) What is the probability that the electron is within 0.5 \AA of the center of the box in the lowest energy state? (10 points)

[Hint] The probability of finding the electron in a finite volume of space is obtained by integration over the volume:

$$\int [\psi_n(x, y, z)]^2 dv$$

and the wavefunction for a particle in a box is:

$$\psi_n = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$$