※ 注意：請於試卷上依序作答，並應註明作答之大題及其題號。

一、分析化學試題 (50%)

1. Drugs often absorb strongly in the uv. As an example, ε_{254} = 16000 and ε_{267} = 19000 for tetracycline, while ε_{254} = 16000 and ε_{267}= 15000 for epi-tetracycline, an inactive hydrolysis product. If a mixture exhibits absorbances of 0.402 at 254 nm and 0.432 at 267 nm, what is the concentration of each compound ? 12%

2. a. If the transmittance of the compound is measured with an uncertainty, σ_T, derive how this uncertainty is propagated to the measured uncertainty of concentration.
b. A spectrophotometric analysis was performed with a manual instrument that exhibited an absolute standard deviation of ±0.003T throughout its transmittance scale. Calculate the relative standard deviation in concentration that results from this uncertainty when the analyte solution has an absorbance of 1.000. 12%

3. a. The voltage for the following cell is 0.503 V at room temperature. Find K_a for the acetic acid.
Pt(s)|H_2 (1.00 bar)|CH_3COOH (0.050 M),CH_3COONa (0.0050 M)||Cl^-(1.0 M)|AgCl(s)|Ag(s), given $E^o(AgCl/Ag)$=0.222 V.
b. Find formation constant for the complex $Ag(S_2O_3)_2^{3-}$, given $E^o(Ag(S_2O_3)_2^{3-}/Ag)$=0.017 V and Ksp(AgCl)=1.82x10^{-10}. 14%

4. An ion having m/q=60 (m: ion mass; q: charge) is driven in a time-of-flight mass spectrometer with a flight length 100 cm and an accelerating voltage 3000 V. Calculate (a) the ion speed, and (b) the arrival time of the ion. 12%
(1 eV= 1.602 x 10^{-12} erg)

二、物化試題 (50%)

1. For an isothermal reversible expansion of an ideal gas (with constant C_v), state whether each of the following is positive, negative or zero: q (heat), w (work), ΔU (U: internal energy), ΔH, ΔS, and ΔG. (no explanation is required) 6%

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2. For an adiabatic reversible compression of 1 mol of an ideal gas (with a molar heat capacity $C_{vm} = 5R/2$) at STP to 2 atm, answer the following questions. 18%

(A) Give the value of $\gamma = C_p/C_v$

(B) Show that $\left(\frac{\partial P}{\partial T}\right)_S = \frac{C_p}{V}$

(C) Show that $P = 3.0\times10^{-9}\times T^{3.5}$.

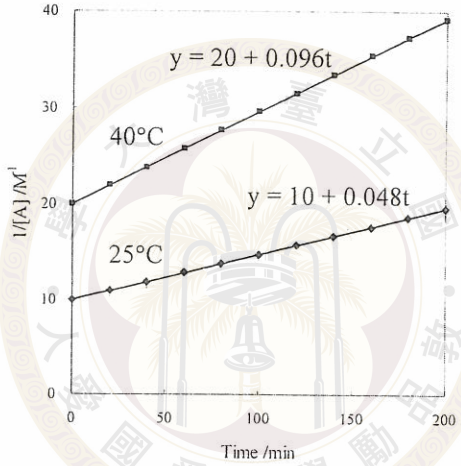
(D) Find the final temperature of the process.

(E) Find the entropy change (ΔS) of the process,

(F) Find the enthalpy change (ΔH) of the process.

(G) Find the work done during the process.

3. The plots of 1/[X] vs. time at 25°C and 40°C for the reaction 2 X → products are shown below. ($R = 8.31\ J\cdot K^{-1}\cdot mol^{-1}$) 12%



(A) Give the rate law of the reaction.

(B) Find the rate constants of the reaction at these two temperatures.

(C) Calculate the half-life of the reaction at 40°C.

(D) Estimate the activation energy (in $kJ\cdot mol^{-1}$) of the reaction.

4. Assume an electron ($m_e = 9.1 \times 10^{-31}$ kg) is confined within 5 nm of a one dimensional particle-in-a-box. Answer the following questions. 14%

(A) Write the Schrödinger equation for the system.

(B) Find the ground state energy of the electron. ($h = 6.625\times10^{-34}$ J·s)

(C) Give four criteria that a trial function must satisfy for use in variation theory.

(D) Assume the function $x(l-x)$ is a trial function for the ground state of the 1-D particle-in-a-box with length l, find the normalization constant for the function.

(E) Find an expression for the energy of the trial function $x(l-x)$.

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