34

淡江大學 104 學年度碩士班招生考試試題

系別：化學工程與材料工程學系 B 組　科目：物理化學

考試日期：3 月 8 日(星期日)第 2 節　　本試題共　　大題，　1 頁

1. **(a)** One mole of an ideal gas originally at 300 K and 1 bar is heated at constant pressure to a temperature of 400 K. The gas has a constant pressure heat capacity (C_p) of 30 J/mol·K. Calculate the changes in the internal energy (ΔU), enthalpy (ΔH), and entropy (ΔS), and the heat (Q) and work (W) for this process. (gas constant, R = 8.314 J/mol·K) (20%)

(b) Then the system is compressed isothermally to a volume equal to its initial volume. Calculate ΔU, ΔH, ΔS, Q, and W for this process. (15%)

2. The Beer–Lambert law states that $A = \log(1/T) = \varepsilon cd$, where A is the absorbance, T is the transmittance, ε is the molar absorption coefficient, c is the concentration, and d is the light path. An aqueous solution of a compound (molar mass 500 g/mol), at a concentration of 50 mg/L, gave an absorbance of 1.0 with a light path of 1 cm.

(a) Calculate the molar absorption coefficient. (5%)

(b) What would be the absorbance and the percentage of transmittance of a 10^{-5} M solution? (10%)

3. **(a)** There is a relationship between the energy of a photon and the wavelength of the light (λ) given by the equation: $E = hc/\lambda$. Estimate the energy (eV) of a photon that has the wavelength of 328 nm. (Plank constant: 6.626×10^{-34} J·s or 4.136×10^{-15} eV·s; the speed of light: 3×10^{8} m/s) (5%)

(b) An electron has a mass (m) of 9.11×10^{-31} kg and a charge of 1.602×10^{-19} C. Calculate the kinetic energy ($mu^2/2$) and the de Broglie wavelength ($\lambda = h/mu$) of an electron that has been accelerated by a potential of 100 V. (10%)

4. A compound adsorbed on graphite is found to obey the Langmuir isotherm: $\theta = KP_A/(1+KP_A)$, where θ is the fraction of the surface covered by adsorbed A ($\theta = 1$ when the surface is saturated) and K is the equilibrium constant. At a pressure of 1 Torr the adsorbed molecules on a sample of graphite was found to be 4 mm^3 at STP (0 °C, 1 atm); at 3 Torr it was 8 mm^3. Calculate the equilibrium constant and the volume (x mm^3 at STP) of this compound adsorbed when the graphite surface is saturated. (10%)

5. An aqueous solution of gold (III) nitrite, $Au(NO_3)_3$, was electrolyzed with a current of 0.05 A until 0.197 g of Au (atomic weight 197 g/mol) had been deposited at the cathode.

The reactions are: $3e^- + Au^{3+} \rightarrow Au$ and $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

Calculate **(a)** the quantity of electricity Q passed (electric charge, SI unit: C), **(b)** the duration (time) of the experiment, and **(c)** the volume of O_2 (at STP) liberated at the anode. The Faraday constant F is equal to 96485 C/mol. (15%)

6. A second-order reaction in solution has a rate constant (k) of 10^{-4} L/mol·s at 27 °C and of 5×10^{-4} L/mol·s at 67 °C. Calculate the activation energy (E), assuming the Arrhenius equation to apply. (Arrhenius equation: $k = Ae^{-E/RT}$) (10%)