

國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別：工程技術研究所碩士班
材料科技學程

組別：乙組

科目：普通化學

共 100 分

1. (15%)

The ionization energy of hydrogen atom is 13.6 eV.

(A) Calculate the wavelength (H_α) of the emission spectrum for atomic hydrogen in the Balmer series where electron jumps from $n_2=3$ to $n_1=2$. (hint: n_1 and n_2 are principal quantum numbers.) (9 分)

(B) At what temperature is the kinetic energy of a hydrogen atom equals to the energy required to remove the electron from a hydrogen atom in its ground state? (6 分)

2. (20%)

(A) Determine the potential E for a concentration cell containing two Ag electrodes dipping into solutions of 1.00 M Ag^+ and 0.001 M Ag^+ at room temperature, separately. (12 分)

(hint: The reduction potential for the half reaction $Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$ is E^θ or 0.799 V)

(B) What are the respective polarities (cathode or anode) of the above electrodes? (4 分)

(C) What is the final concentration of each half cell when E approaches zero? (4 分)

3. (15%)

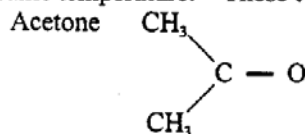
Two gases (N_2 and O_2) are trapped on opposite sides of a movable piston. The piston is allowed to move until the gas pressure on both sides are equal, at which point the entire apparatus is immersed in a constant temperature bath at 298 K. Assume both N_2 and O_2 exhibit ideal gas behavior. (Atomic weight of N and O are 14.00 and 16.00, respectively.)

(A) What is the average internal energy per mole of N_2 (J/mol)? (7 分)

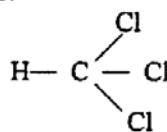
(B) What is the speed of O_2 molecules (m/s)? (8 分)

4. (20%)

Pure acetone has a vapor pressure of 358 torr at 35°C. Pure chloroform has a vapor pressure of 328 torr at the same temperature. These two liquids can be mixed in any ratio.



Chloroform



(A) Construct a graph of the vapor pressure curves for an ideal solution A+B, including partial pressure of P_A , P_B and total pressure P_T . (as predicted by the Raoult's law). Plot mole fraction along the ordinate versus vapor pressure along the abscissa. (5 分)

(B) Construct a graph of the vapor pressure curves for solutions of acetone and chloroform. (5 分)

(C) How does the acetone/chloroform solution deviate from ideal solution? Develop a simple explanation to the deviation. (6 分)

(D) Is the reaction of mixing endothermic or exothermic? (4 分)

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5. (10%)

- (A) In an octahedral complex, the five d orbitals of transition metal atoms or ions are split into two sets that differ by the energy Δ_0 . Draw the two sets energy-level structures t_{2g} and e_g that separated by Δ_0 . Place the five d orbitals in proper locations. (4 分)
- (B) The octahedral complex ions $[\text{FeCl}_6]^{3-}$ and $[\text{Fe}(\text{CN})_6]^{3-}$ are both paramagnetic, but the former is high-spin and the latter is low spin. Identify the d electron configurations in these two octahedral complex ions. (6 分)
- (hint: Fe^{3+} ion has 5 d electrons.)

6. (20%)

Consider a hypothetical reaction in which A is observed to decompose to products according to the following equation:



- (A) Write the rate equation for such a first order reaction in terms of disappearance of A. (4 分)
- (B) Describe the way to determine the rate constant of above reaction. (6 分)
- (C) Describe the way to determine the activation energy of above reaction. (6 分)
- (D) Which energy (Figure 1. E_1, E_2, E_3) is the activation energy of above reaction? (4 分)

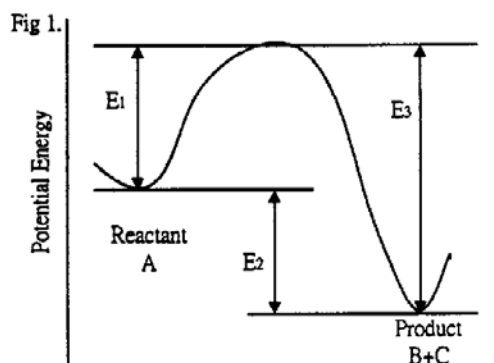


Table of Values

Quantity	Symbol	Value	CGS	SI
Velocity of light	c	2.997925	$10^{10} \text{ cm s}^{-1}$	10^8 m s^{-1}
Proton charge	e	1.60219	—	10^{-19} C
		4.80325	10^{-10} esu	—
Planck's constant	h	6.62620	10^{-27} erg s	10^{-34} J s
	$\hbar = h/2\pi$	1.05459	10^{-27} erg s	10^{-34} J s
Avogadro's number	N	$6.02217 \times 10^{23} \text{ mol}^{-1}$	—	—
Atomic mass unit	amu	1.66053	10^{-24} g	10^{-27} kg
Electron rest mass	m	9.10956	10^{-28} g	10^{-31} kg
Proton rest mass	M_p	1.67261	10^{-24} g	10^{-27} kg
Proton mass/electron mass	M_p/m	1836.1	—	—
1 electron volt	eV	1.60219	10^{-12} erg	10^{-19} J
	eV/h	$2.41797 \times 10^{14} \text{ Hz}$	—	—
	eV/hc	8.06546	10^3 cm^{-1}	10^5 m^{-1}
	eV/ k_B	$1.16048 \times 10^4 \text{ K}$	—	—
Boltzmann constant	k_B	1.38062	$10^{-16} \text{ erg K}^{-1}$	$10^{-23} \text{ J K}^{-1}$
Permittivity of free space	ϵ_0	—	1	$10^7/4\pi c^2$
Permeability of free space	μ_0	—	1	$4\pi \times 10^{-7}$