

國立高雄大學九十五學年度轉學招生考試試題

科目：普通物理與微積分

系所：應用化學系二年級

可

使用計算機

考試時間：90 分鐘

本科原始成績：滿分 100 分

否

Note: 請將題號及計算過程與答案寫在答案卷上。

Part I: 物理 50%

1. (a) 寫出電學高斯定律(Gauss' Law)。(2%)
 (b) 利用高斯定律求一無窮大帶電荷平板(電荷密度為 σ)之電場。(4%)
 (c) 今將一帶正電荷大平板(面積為 A ，電荷密度為 σ)與另一帶負電荷大平板(面積為 A ，電荷密度為 $-\sigma$)形成一平行板電容器，二板相距 d ，二板內為真空。不計邊緣效應，利用(b)的結果求電容 $C=?$ (4%)
2. (a) 寫出磁學安培定律(Ampere's Law)。(2%)
 (b) 利用安培定律求一無窮長直載流細導線(電流為 I)之磁場。(4%)
 (c) 利用安培定律求一無窮長直載流圓柱導線(半徑 a ，內有均勻電流 I)內之磁場。(4%)
3. (a) 敘述光學中之費瑪原理(Fermat's Principle)。(3%)
 (b) 利用費瑪原理證明光學中之折射定律(Snell's Law of Refraction)。(7%)
4. (a) 證明單擺(Simple Pendulum)於小角度擺動下，其週期為 $T = 2\pi\sqrt{L/g}$ ，其中 L 為擺長， g 為重力加速度。(7%)
 (b) 敘述轉動力學中之平行軸定理 (Parallel-axis Theorem)。(3%)
5. (a) 敘述熱力學第一定律 (First Law of Thermodynamics)。(2%)
 (b) 寫出理想氣體方程式 (Ideal Gas State Equation)。(2%)
 (c) 理想氣體於絕熱過程中遵守： $PV^\gamma = \text{constant}$ ，請問 γ 定義為何？(2%)
 (d) 寫出 Einstein 的光電方程式 (Photoelectric Equation)。(2%)
 (e) 寫出一維薛丁格方程式 (One-dimensional Schrodinger's Equation)。(2%)

Part II: 微積分 50%

1. 求極限 $\lim_{x \rightarrow \infty} (1 + \frac{a}{x})^x$ (5%)
2. 求定積分 $\int \frac{\ln x}{x^2} dx$ (5%)
3. 求不定積分 $\int \frac{1}{1 - \sin x} dx$ (10%)
4. 求體積分 $\iiint_V \frac{1}{16 - x^2 - y^2 - z^2} dx dy dz$ ，球體積 $V: x^2 + y^2 + z^2 \leq 3$ (10%)
5. 求線積分 $\int_C x^2 y dx + xy dy$ ，這裏的路徑 $C: x = \sqrt{1 - y^2}$ 且 $(1, 0) \rightarrow (0, 1)$ (10%)
6. 求級數 $\sum_{n=1}^{\infty} \frac{n^2}{2^n}$ (10%)

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< I > 單一選擇題(共佔 45 分，每題 3 分，答錯不倒扣，請依題序將答案寫在答案紙上)

- A 100-mL sample of water is placed in a coffee cup calorimeter. When 1.0 g of an ionic solid is added, the temperature decreases from 21.5°C to 20.8°C as the solid dissolves. For the dissolving of the solid
 - $\Delta H < 0$
 - $\Delta S_{\text{univ}} > 0$
 - $\Delta S_{\text{sys}} < 0$
 - $\Delta S_{\text{surr}} > 0$
 - none of these
- For a particular chemical reaction
 $\Delta H = 5.5 \text{ kJ}$ and $\Delta S = -25 \text{ J/K}$
 Under what temperature condition is the reaction spontaneous?
 - When $T < -220 \text{ K}$.
 - When $T < 220 \text{ K}$.
 - When $T > 220 \text{ K}$.
 - The reaction is not spontaneous at all temperatures.
 - The reaction is spontaneous at any temperature.
- Iron is biologically important in the transport of oxygen by red blood cells from the lungs to the various organs of the body. In the blood of an adult human, there are approximately 2.60×10^{13} red blood cells with a total of 2.90 g of iron. On the average, how many iron atoms are present in each red blood cell? (molar mass (Fe) = 55.85 g)
 - 8.33×10^{-10}
 - 1.2×10^9
 - 3.12×10^{22}
 - 2.60×10^{13}
 - none of these
- On a relative basis, the weaker the intermolecular forces in a substance,
 - the greater its heat of vaporization.
 - the more it deviates from ideal gas behavior.
 - the greater its vapor pressure at a particular temperature.
 - the higher its melting point.
 - none of these
- A solution consists of a mixture of benzene and toluene and is allowed to come to equilibrium with its vapor. The vapor is then condensed and found to contain 50.0 mole percent of each component. Calculate the composition (mole percent) of the original solution. The vapor pressures of pure benzene and toluene at this temperature are 750. torr and 300. torr, respectively.
 - 28.6% benzene
 - 40.0% benzene
 - 50.2% benzene
 - 71.0% benzene
 - none of these

6. the gas-phase decomposition of ethylene chloride.



Experiment shows that the decomposition is first order.

The following data show kinetics information for this reaction:

Time (s)	$\ln [\text{C}_2\text{H}_5\text{Cl}] (\text{M})$
1.0	-1.625
2.0	-1.735

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What is the rate constant for this decomposition?

- a) 0.29/s b) 0.35/s c) 0.11/s d) 0.02/s e) 0.22/s

7. Which of the following statements is true?

- a) An endothermic reaction shifts toward reactants when heat is added to the reaction.
 b) Catalysts are an effective means of changing the position of an equilibrium.
 c) The concentration of the products equals that of reactants and is constant at equilibrium.
 d) When two opposing processes are proceeding at identical rates, the system is at equilibrium.
 e) None of these statements is true.

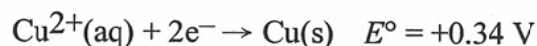
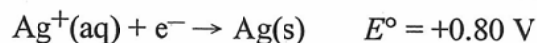
8. The equilibrium constants (K_a) for HCN and HF in H_2O at $25^\circ C$ are 6.2×10^{-10} and 7.2×10^{-4} , respectively. The relative order of base strengths is:

- a) $F^- > H_2O > CN^-$ b) $H_2O > F^- > CN^-$ c) $CN^- > F^- > H_2O$
 d) $F^- > CN^- > H_2O$ e) none of these

9. The heat of vaporization for 1.0 mole of water at $100^\circ C$ and 1.0 atm is 40.6 kJ/mol. Calculate ΔS for the process $H_2O(l) \rightarrow H_2O(g)$ at $100^\circ C$.

- a) 109 J/K mol b) -109 J/K mol c) 406 J/K mol
 d) -406 J/K mol e) none of these

10. A strip of copper is placed in a 1 M solution of copper nitrate and a strip of silver is placed in a 1 M solution of silver nitrate. The two metal strips are connected to a voltmeter by wires and a salt bridge connects the solutions. The following standard reduction potentials apply:



When the voltmeter is removed and the two electrodes are connected by a wire, which of the following does not take place?

- a) Electrons flow in the external circuit from the copper electrode to the silver electrode.
 b) The silver electrode increases in mass as the cell operates.
 c) Some positive copper ions pass through the salt bridge from the copper half-cell to the silver half-cell.
 d) Negative ions pass through the salt bridge from the silver half-cell to the copper half-cell.
 e) none of these

11. Which of the following statements concerning the complex ion $Co(en)_2Cl_2^+$ is true? (en = ethylenediamine, $NH_2CH_2CH_2NH_2$)?

- a) The complex ion contains Co(I).
 b) The complex ion exhibits *cis* and *trans* geometric isomers, but no optical isomers.
 c) The complex ion exhibits two geometric isomers (*cis* and *trans*) and two optical isomers.
 d) Since en is a strong field ligand (large Δ), the complex ion is paramagnetic.
 e) The geometric isomers of the complex ion have identical chemical properties

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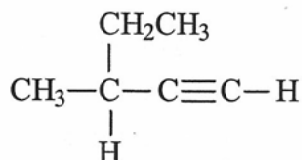
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12. How many isomers are there of "dichloroethene"?

- a) 2 b) 3 c) 4 d) 5 e) 6

13. Name the following:



- a) 1-hexyne b) 2-ethynyl butane c) 2-ethyl-3-butyne
 d) 3-methyl-1-pentyne e) 3-methyl-4-pentyne

14. Which of the following statements is (are) true?

- I. An excited atom can return to its ground state by absorbing electromagnetic radiation.
 II. The energy of an atom is increased when electromagnetic radiation is emitted from it.
 III. The energy of electromagnetic radiation increases as its frequency increases.
 IV. An electron in the $n = 4$ state in the hydrogen atom can go to the $n = 2$ state by emitting electromagnetic radiation at the appropriate frequency.
 V. The frequency and wavelength of electromagnetic radiation are inversely proportional to each other.

- a) II, III, IV b) III, V c) I, II, III d) III, IV, V e) I, II, IV

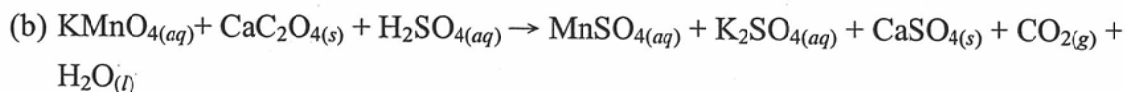
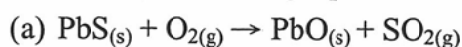
15. The hybridization of the central atom in I_3^- is:

- a) sp b) sp^2 c) sp^3 d) dsp^3 e) $d^2 sp^3$

< II > 計算題(共佔 55 分)

(10%) 1. Biochemists have discovered more than 400 mutant varieties of hemoglobin, the blood protein that carries oxygen throughout the body. A physician studying a variety associated with a fatal disease first finds its molar mass (M). She dissolves 21.5 mg of the protein in water at 5.0°C to make 1.50 mL of solution and measures an osmotic pressure of 0.00475 atm. What is the molar mass of this variety of hemoglobin? ($R = 0.0821 \text{ atm}\cdot\text{L}/\text{mol}\cdot\text{K}$)

(10%) 2. Balance the following equations:



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- (15%) 3. Ascorbic acid ($\text{H}_2\text{C}_6\text{H}_6\text{O}_6$; H_2Asc for this problem) known as vitamin C, is a diprotic acid ($K_{a1} = 1.0 \times 10^{-5}$ and $K_{a2} = 5 \times 10^{-12}$) found in citrus fruit. Calculate $[\text{H}_2\text{Asc}]$, $[\text{HAsc}^-]$, and $[\text{Asc}^{2-}]$ of 0.050 M H_2Asc .
- (20%) 4. In black-and-white film developing, excess AgBr is removed from the film negative by “hypo”, an aqueous solution of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$), which forms the complex ion $\text{Ag}(\text{S}_2\text{O}_3)_2^{3-}$. Calculate the solubility of AgBr in (a) H_2O ; (b) 1.0M hypo. K_f of $\text{Ag}(\text{S}_2\text{O}_3)_2^{3-}$ is 4.7×10^{13} and K_{sp} of AgBr is 5.0×10^{-13} .