

國立高雄大學九十七學年度轉學招生考試試題

科目：普通化學
考試時間：80 分鐘

系所：
化學工程及材料工程學系轉二年級 是否使用計算機：是
本科原始成績：100 分

1. Give the systematic name of each of the following compounds. (10%)
a. AlCl_3 b. HgO c. CoBr_2 d. Na_2CO_3 e. P_4O_{10}
2. Nitrogen gas can be prepared by passing gaseous ammonia over solid copper(II) oxide at high temperatures. The other products of the reaction are solid copper and water vapor. If a sample containing 18.1 g of NH_3 is reacted with 90.4 g of CuO , which is the limiting reactant? How many grams of N_2 will be formed? (10%)

3. Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) is a bright orange compound that can be reduced to a blue-violet solution of Cr^{3+} ions. Under certain conditions, $\text{K}_2\text{Cr}_2\text{O}_7$ reacts with ethyl alcohol ($\text{C}_2\text{H}_5\text{OH}$) as follows :



Balance this equation using the half-reaction method. (8%)

4. Calculate the standard enthalpy change for the overall reaction that occurs when ammonia is burned in air to form nitrogen dioxide and water. This is the first step in the manufacture of nitric acid. (ΔH_f° for $\text{NH}_3 = -46 \text{ kJ/mol}$, ΔH_f° for $\text{O}_2 = 34 \text{ kJ/mol}$) (8%)



5. Write Lewis structures and predict the molecular structures of OCl_2 , NF_3 , and AsF_5 . Which of these compounds are polar? (10%)
6. Use the molecular orbital model to predict the magnetism and bond order of O_2 and P_2 . (10%)
7. A solution is prepared by mixing 5.81 g acetone ($\text{C}_3\text{H}_6\text{O}$, molar mass = 58.1 g/mol) and 11.9 g chloroform (HCCl_3 , molar mass = 119.4 g/mol). At 35°C , this solution has a total vapor pressure of 260. torr. What is the expected vapor pressure? Is this an ideal solution? Explain why. The vapor pressures of pure acetone and pure chloroform at 35°C are 345 and 293 torr, respectively. (8%)
8. The gas-phase reaction between methane and diatomic sulfur is given by the equation



At 550°C the rate constant for this reaction is $1.1 \text{ L/mol} \cdot \text{s}$, and at 625°C the rate constant is $6.4 \text{ L/mol} \cdot \text{s}$. Using these values, calculate E_a for this reaction. ($\ln 5.82 = 1.76$) (6%)

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9. A chemist has synthesized a monoprotic weak acid and wants to determine its K_a value. To do so, the chemist dissolves 2.00 mmol of the solid acid in 100.0 mL water and titrates the resulting solution with 0.0500 M NaOH. After 20.0 mL NaOH has been added, the pH is 6.00. What is the K_a value for the acid? (10%)

10. Place the species in each of the following groups in order of increasing acid strength.

a. H_2O , H_2S , H_2Se (bond energies: $\text{H}-\text{O}$, 467 kJ/mol; $\text{H}-\text{S}$, 363kJ/mol; $\text{H}-\text{Se}$, 276 kJ/mol) (4%)

b. $\text{CH}_3\text{CO}_2\text{H}$, $\text{FCH}_2\text{CO}_2\text{H}$, $\text{F}_2\text{CHCO}_2\text{H}$, $\text{F}_3\text{CCO}_2\text{H}$ (4%)

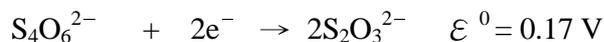
c. HClO_4 , HClO_3 , HClO_2 (4%)

Give reasons for the orders you chose.

11. For the oxidation-reduction reaction:



The appropriate half-reactions are



Balance the redox reaction, and calculate ε^0 and K (at 25°C). (8%)

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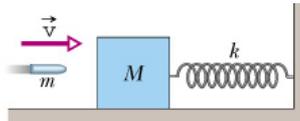
科目：普通物理
考試時間：80 分鐘

系所：化學工程及材料工程學系轉二年級 是否使用計算機：是
本科原始成績：100 分

1. Fig. 1 shows two 22.7 kg ice sleds that are placed a short distance apart, one directly behind the other. A 3.63 kg cat initially standing on one sled jumps to the other one and then back to the first. Both jumps are made at a speed of 3.05 m/s relative to the ice. What are the final speeds of (a) the first sled and (b) the other side. (a : 7 points ; b : 8 points)



2. A block of mass $M=5.4\text{kg}$, at rest on a horizontal frictionless table, is attached to a rigid support by a spring of constant $k=6000\text{ N/m}$. A bullet of mass $m=9.6\text{g}$ and velocity $v=630\text{ m/s}$ strikes and is embedded in the block. Assuming the compression of the spring is negligible until the bullet is embedded, determine (a) the speed of the block immediately after the collision and (b) the amplitude of the resulting simple harmonic motion. (a : 7 points ; b : 8 points)



3. A boy is initially seated on the top of a hemispherical ice mound of radius $R=13.8\text{ m}$. He begins to slide down the ice, with a negligible initial speed. The ice is frictionless. At what height does the boy lose contact with the ice? (10 points)



4. On a hot day in Las Vegas, an oil trucker loaded 37,000 L of diesel fuel. He encountered cold weather on the way to Utah, where the temperature was 23K lower than in Las Vegas, and he delivered his entire load. How many liters did he deliver? The coefficient of volume expansion for diesel fuel is $9.5 \times 10^{-4}/^\circ\text{C}$, and the coefficient of linear expansion for his steel truck tank is $11 \times 10^{-6}/^\circ\text{C}$. (10 points)
5. In Fig. 5, a small, nonconducting ball of mass $m=1\text{ mg}$ and charge $q=2 \times 10^{-8}\text{ C}$ (distributed uniformly through its volume) hangs from an insulating thread that makes an angle $\theta=30^\circ$ with a

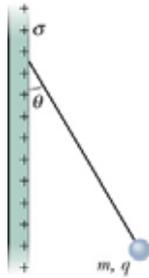
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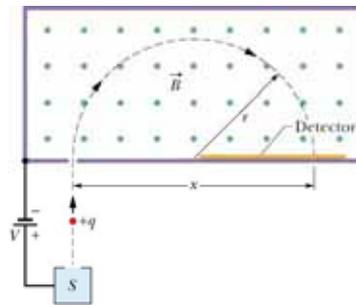
vertical, uniformly charged nonconducting sheet (shown in cross section). Considering the gravitational force on the ball and assuming the sheet extends far vertically and into and out of page, calculate the surface charge density σ of the sheet. (10 points)

Fig. 5



6. Fig. 6 shows the essentials of a mass spectrometer; an ion of mass m and charge q is produced in source S. The initially stationary ion is accelerated by the electric field due to a potential difference V . The ion leaves S and enters a separator chamber in which a uniform magnetic field B is perpendicular to the path of the ion. A wide detector lines the bottom wall of the chamber, and the B causes the ion move in as semicircle and thus strike the detector. Suppose that $B=80$ mT, $V=1000$ V, and ions of charge $q=1.6 \times 10^{-19}$ C strike the detector at a point that lies at $x=1.6254$ m. What is the mass m of individual ions. (10 points)

Fig. 6



7. A wave traveling along a string is described by

$$y(x,t)=0.00327 \sin(72.1x-2.72t)$$
 in which the constants are in SI units (0.00327m, 72.1rad/m, and 2.72 rad/s)
 (a) What is the amplitude of this wave ? (4 points)
 (b) What are the wavelength, period, and frequency of this wave? (12 points)
 (c) What is the velocity of this wave? (4 points)
8. A structural steel rod has a radius R of 9.5 mm and a length L of 81 cm. A 62 kN force stretches it along its length. What are the stress on the rod and the elongation of the rod? ($E=2 \times 10^{11}$ N/m²) (10 points)