

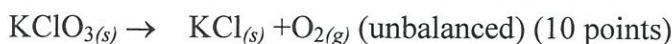
國立臺灣師範大學 105 學年度碩士班招生考試試題

科目：普通化學

適用系所：科學教育研究所

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

1. A mixture of KCl and KClO_3 weighting 1.34 grams was heated; the O_2 is collected over water which generated occupied 143 mL at STP. (The vapor pressure of water at this temperature is 26 torr). What percent of the original mixture was KClO_3 , which decomposes as the equation listed below. (MW of $\text{KClO}_3 = 122.55 \text{ g/mol}$)



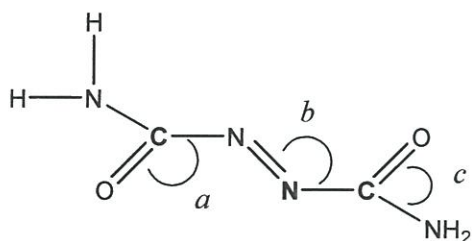
2. (i) Draw the most stable Lewis structure. (ii) Indicate any nonzero formal charges of each atom. (iii) Name the geometry and (iv) Whether it has dipole moment or not for following compounds.
1. COCl_2 , 2. NO_2^- , 3. SO_3^{2-} . (12 points)

3. Now consider the following species: CN , CN^+ , CN^-

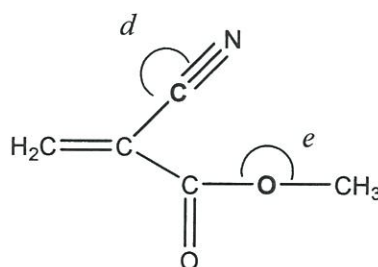
- (i) (2 points) What is the ordering of dissociation energy of these species?
- (ii) (2 points) What is the ordering of bond length of these species?
- (iii) (2 points) What is the outer (valence) electron configuration of CN^+ .
- (iv) (2 points) Which one is paramagnetic and will be attracted by a magnetic field?

4. Carbonate buffer are important in regulating the pH of blood at 7.4. If the carbonic acid concentration in a sample of blood is 0.0012 M . determine the bicarbonate ion concentration required to buffer the pH of blood at $\text{pH}=7.40$. $K_a=4.3 \times 10^{-7}$. (10 points)

5. These two molecules used in the polymer industry. i. Please indicate the hybrid orbitals of atoms in bold. ii. Bond angles marked a through e in the structures. (10 points)



Azodicarbonamide



Methyl cyanoacrylate

6. Which of the following sets of quantum numbers are not allowed? For each incorrect set, state why it is incorrect. (10 points)

- A. $n = 1, l = 1, m_l = 0, m_s = \frac{1}{2}$ B. $n = 4, l = 2, m_l = 0, m_s = \frac{1}{2}$
 C. $n = 4, l = 1, m_l = -1, m_s = \frac{1}{2}$ D. $n = 4, l = -2, m_l = 0, m_s = -\frac{1}{2}$ E. $n = 3, l = 1, m_l = 2, m_s = \frac{1}{2}$

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7. Calculate the lattice energy for $\text{LiCl}_{(s)}$, given the following: (10 points)

sublimation energy for $\text{Li}_{(s)}$ +166 kJ/mol

H_f for $\text{Cl}_{(g)}$ +119 kJ/mol

first ionization energy of $\text{Li}_{(g)}$ +520. kJ/mol

electron affinity of $\text{Cl}_{(g)}$ -349 kJ/mol

enthalpy of formation of $\text{LiCl}_{(s)}$ -409 kJ/mol

8. The reaction between bromate ions in acidic aqueous solution is given by the equation

$\text{BrO}_3^-(aq) + 5\text{Br}^-(aq) + 6\text{H}^+(aq) \rightarrow 2\text{Br}_{2(l)} + 3\text{H}_2\text{O}_{(l)}$. Please use the results from four experiments to determine the order reactants, and the value of the rate constant. (10 points)

Experiment	Initial $\text{BrO}_3^-(\text{mol/L})$	Initial $\text{Br}^-(\text{mol/L})$	Initial $\text{H}^+(\text{mol/L})$	Measured initial rate ($\text{mol/L}\cdot\text{s}$)
1	0.10	0.10	0.10	8.0×10^{-4}
2	0.20	0.10	0.10	1.6×10^{-3}
3	0.20	0.20	0.10	3.2×10^{-3}
4	0.10	0.10	0.20	3.2×10^{-3}

9. For each of the following pairs, predict which substance is more soluble in water (10 points)

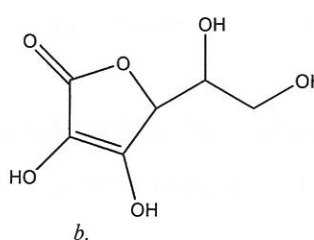
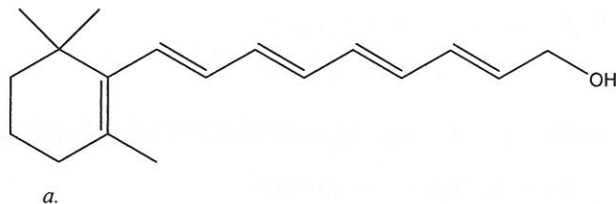
a. PH_3 or NH_3

b. CH_3CN or CH_3OH

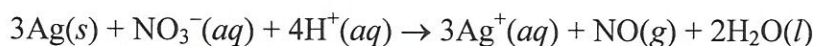
c. $(\text{CH}_3)_3\text{COH}$ or $\text{CH}_3(\text{CH}_2)_6\text{OH}$

d. CH_3OH or $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

e.



10. The following question refers to the following system:



Anode reaction: $\text{Ag} \rightarrow \text{Ag}^+(aq) + 1e^-$ $\mathcal{E}^\circ = -0.7990\text{V}$

Cathode reaction: $\text{NO}_3^-(aq) + 4\text{H}^+(aq) + 3e^- \rightarrow \text{NO}_{(g)} + 2\text{H}_2\text{O}_{(l)}$ $\mathcal{E}^\circ = 0.9636\text{V}$

determine the equilibrium constant at 25°C . (10 points)