

# 國立中央大學九十學年度碩士班研究生入學試題卷

所別: 化學學系 不分組 科目: 綜合化學 共 1 頁 第 1 頁

- Draw all the geometrical isomers of  $[\text{Cr}(\text{en})(\text{NH}_3)_2\text{BrCl}]^+$ . Which of these isomers also has an optical isomer? Draw all of them. (17 pts)
- Predict the molecular structure and the bond angles for each of the following ions. (18 pts)  
(a)  $\text{XeF}_2$ , (b)  $\text{IF}_3$ , (c)  $\text{IF}_4^+$ , (d)  $\text{SF}_3^+$ , (e)  $\text{BrF}_6^-$ , (f)  $\text{XeO}_2\text{F}_2$ .
- The compounds  $\text{NF}_3$  is quite stable, but  $\text{NCl}_3$  is very unstable. The compounds  $\text{NBr}_3$  and  $\text{NI}_3$  are still unknown, though the explosive  $\text{NI}_3 \cdot \text{NH}_3$  is known. How do you account for the instability of these halides of nitrogen? (15 pts)
- (i) If we put 40g of sodium acetate into 500 ml 0.4M acetic acid to form a buffered solution, how many moles of NaOH can we add to this solution with  $\Delta\text{pH} < 1$ ? (acetic acid,  $K_a = 1.8 \times 10^{-5}$ ) (7 pts)  
(ii) If we have three cations ( $\text{Ag}^+$ ,  $\text{Ba}^{2+}$ , and  $\text{Fe}^{3+}$ ) and three solutions ( $\text{NaCl}_{(\text{aq})}$ ,  $\text{Na}_2\text{SO}_4_{(\text{aq})}$ , and  $\text{NaOH}_{(\text{aq})}$ ), please make a table to indicate which of the nine reactions between these cations and solutions will form precipitation. And, what is the color and molecular formula for each precipitate? (9 pts)  
(iii) In a galvanic cell setup, we have 2.0M  $\text{AgNO}_3_{(\text{aq})}$  in the left cell while we put 2g  $\text{AgCl}_{(\text{s})}$  and 5.85g  $\text{NaCl}_{(\text{s})}$  into the right cell with 500mL water, what is the voltage of this galvanic cell at 298K? ( $\text{AgCl}_{(\text{s})}$ ,  $K_{sp} = 1.6 \times 10^{-10}$ ,  $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$   $\epsilon^\circ = +0.80\text{V}$ ) (7 pts)
- (i) Please determine the formal charges of every atom in the following molecules:  $\text{I}_3^-$ ,  $\text{SO}_2$ ,  $\text{CO}_3^{2-}$  and use VSEPR (Valence Shell Electron Pair Repulsion) model to predict the shape, bond angle, and the orbital hybridization type for each molecule. (12 pts)  
(ii) Please draw the molecular orbital (MO) energy level diagram for  $\text{B}_2$  and  $\text{O}_2$ . Please also determine bond order and magnetic property (diamagnetic or paramagnetic) for these two molecules. (8 pts)
- There is a reaction:  $2\text{A} \rightarrow 2\text{B} + \text{D}$ . The mechanism is as follows:  
 $\text{A} \leftrightarrow \text{B} + \text{C}$  (Rate Constant:  $k_1 \rightarrow$ ,  $k_1 \leftarrow$ )  
 $\text{A} + \text{C} \xrightarrow{k_2} \text{B} + \text{D}$  (Rate Constant:  $k_2$ )  
 Please use the Steady State Approximation model to show that (if  $k_2 \gg k_1$ ) the production rate of D is a 1<sup>st</sup> order reaction. (7 pts)  
 (Appendix:  $\log 2 = 0.3010$ ,  $\log 3 = 0.4771$ ,  $\log 5 = 0.6990$ ,  $\log 7 = 0.8451$ . Atomic weight:  $\text{Ag} = 107.86$ ,  $\text{Cl} = 35.45$ ,  $\text{Na} = 23.0$ ,  $\text{O} = 16.0$ ,  $\text{H} = 1.0$ ,  $\text{C} = 12.0$ )