

# 國立成功大學

## 113學年度碩士班招生考試試題

編 號：76

系 所：化學工程學系

科 目：無機化學及分析化學

日 期：0201

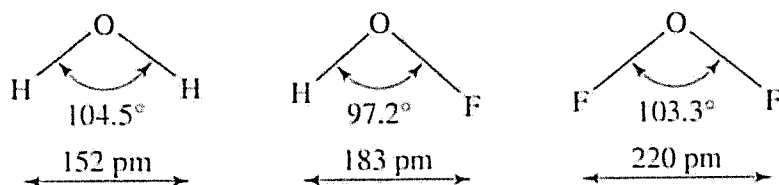
節 次：第 2 節

備 註：可使用計算機

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Part I Inorganic Chemistry (50%)

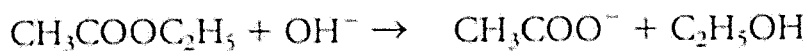
- (1) Consider the following molecules. Using LCP approach, provide a rationale for HOF having the smallest bond angle in this set (10%).



- (2) Give Lewis dot structures and shapes for the following: a.  $\text{VOCl}_3$  (5%), b.  $\text{SOF}_4$  (5%); Which of the molecules are polar (5%)?
- (3) For trans-1,2-dichloroethylene, which has  $C_{2h}$  symmetry,
- List all the symmetry operations for this molecule (5%).
  - Write a set of transformation matrices that describe the effect of each symmetry operation in the  $C_{2h}$  group on a set of coordinates  $x, y, z$  for a point (5%).
  - Using the terms along the diagonal, obtain as many irreducible representations as possible from the transformation matrices (5%).
- (4) Prepare a molecular orbital energy-level diagram for NO, showing clearly how the atomic orbitals interact to form MOs, and explain how does your diagram illustrate the difference in electronegativity between N and O (5%)? Predict the bond order and the number of unpaired electrons (5%).

Part II Analytical Chemistry (50%)

- (5) What mass of sodium formate must be added to 500.0 mL of 1.00 M formic acid ( $\text{pK}_a = 1.8 \times 10^{-4}$ ) to produce a buffer solution that has a pH of 3.50 (10%)?
- (6) The ethyl acetate concentration in an alcoholic solution was determined by diluting a 10.00-mL sample to 100.00 mL. A 20.00-mL portion of the diluted solution was refluxed with 40.00 mL of 0.04672 M KOH:



After cooling, the excess  $\text{OH}^-$  was back-titrated with 3.41 mL of 0.05042 M  $\text{H}_2\text{SO}_4$ . Calculate the amount of ethyl acetate (88.11 g/mol) in the original sample in grams (10%).

- (7) What is the pH of the solution that results when 0.093 g of  $\text{Mg}(\text{OH})_2$  ( $\text{MW} = 58.32$ ;  $K_{\text{sp}} = 7.1 \times 10^{-12}$ ) is mixed with
- 75.0 mL of 0.0500 M HCl (5%)?
  - 100.0 mL of 0.0500 M HCl (5%)?
  - 15.0 mL of 0.0500 M HCl (5%)?
  - 30.0 mL of 0.0500 M  $\text{MgCl}_2$  (5%)?

(8) The solubility-product constant for  $\text{Ag}_2\text{SO}_3$  is  $1.5 \times 10^{-14}$ , and  $E^0$  for  $2\text{Ag}^+ + 2\text{e}^- \rightleftharpoons 2\text{Ag}(s)$  is 0.779 V.

Calculate  $E^0$  for the process  $\text{Ag}_2\text{SO}_3(s) + 2\text{e}^- \rightleftharpoons 2\text{Ag} + \text{SO}_3^{2-}$  (10%).