國立臺灣師範大學 109 學年度碩士班招生考試試題

科目：分析化學　　適用系所：化學系

注意：1.本試題共 4 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。

I. Calculation questions (8 points each)

1. For the titration of 50.00 mL of 0.1000 M maleic acid, HOOC-CH=CH-COOH, with 0.1000 M NaOH, (maleic acid, $K_{a1} = 1.3 \times 10^{-2}$, $K_{a2} = 5.9 \times 10^{-7}$)
   A. At the first equivalence point (50.00 mL of NaOH is added), NaHM is formed. $[H_3O^+]$ is related to concentration of NaHM, K_{a1}, K_{a2} and K_w. Deduce this equation.
   B. Calculate the pH value at the first equivalence point.
   C. Calculate the pH value when 51.00 mL of NaOH is added.

2. A 0.8787-g sample containing lead (207.5), magnesium (24.305), and zinc (65.39) was dissolved and treated with excess cyanide and then titrated with standard 0.03 M EDTA. It required 45.50 mL EDTA. After the equivalence point had been reached, a solution of the complexing agent BAL (2,3-dimercaptopropanol) is added to the solution. Titration of these released EDTA consumed 20.15 mL of 0.0100 M Mg^{2+}. After addition of formaldehyde, the liberated ion was titrated 29.80 mL of EDTA. Calculate the percent of the three elements in the sample.

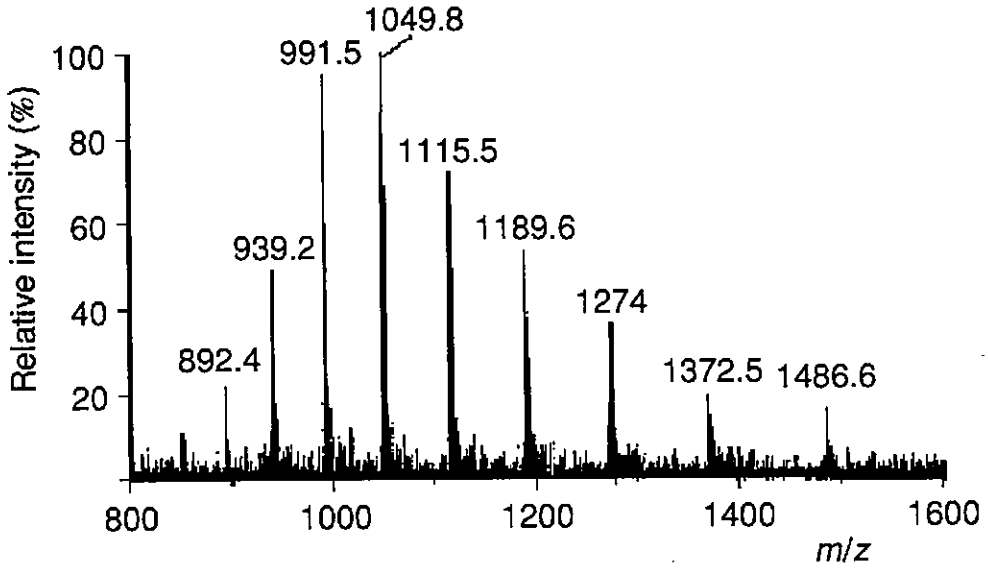
3. Substances A and B have retention times of 10.20 and 11.60 min, respectively, on a 10.0-cm column. An unretained species passes through the column in 1.02 min. The peak widths (at base) for A and B are 0.69 and 0.83 min, respectively. Calculate
   A. the column resolution
   B. the average number of plates in the column
   C. the plate height
   D. the length of column required to achieve a resolution of 2.5, and the time required to elute substance B on the column that gives an Rs value of 2.5.

4. To calculate Ca in cereal 0.533 g of crushed cereal was ashed in a crucbile at 600 °C in air for 3 h. The resdue was dissolved in 6M HCl, quantitatively transffered to a volumetric flask, and diluted to 100.0 mL. Then 5.00-mL aliquot were tranferred to 50-mL volumetric flasks. Each was treated with standard Ca^{2+} (containing 20 μg/mL), diluted to volume with H2O, and analyzed by flame atomic absorption.
   A. Construct a standard addition graph, determine the equation of the calibration curve and find the x-intercept.

B. Find the w% Ca in cereal ssmple.

Ca^{2+} standard (mL)	Absorbance
0	0.152
5.00	0.299
10.00	0.448
15.00	0.570
20.00	0.735

5. Calculate the molecular mass of the compound based on the positive ion electrospray spectrum below.



II. Multiple-choice question (Choose the **best** answer for each question) (4 points each)

1. Which of a typical quantitative analysis step is frequently the most difficult step and the source of greatest error?
(A) acquiring the sample (B) choosing an analytical method (C) processing the sample (D) eliminating interferences (E) calibrating and measuring concentration

2. In a lab, an acid is usually chosen as a permanent reference standard in a preference to a base. In selecting an acid to use in standard solution all of the following factors should be considered except:
(A) the acid should be highly dissociated (B) the acid should not be volatile (C) salts of the acid should be soluble (D) the acid should be a strong oxidizing agent (E) a solution of the acid should be stable

3. Which of the following is the strongest Lewis base?
   (A) BH_3 (B) CH_4 (C) HF (D) H_2O (E) NH_3

4. Living tissues are very sensitive to any changes in the composition of the fluids that bathe them. Thus the maintenance of an almost constant pH in the blood is necessary and is achieved by the many buffers present in that body fluids. Listed below are several of these buffers, choose the one(s) which are not active in the blood.
   (A) chlorides (B) hemoglobin (C) phosphate (D) proteins (E) two of the above

5. The amount of chloride in a water supply is determined by titrating the sample against $AgNO_3$ as follows:
   $AgNO_{3(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)} + NO3^-_{(aq)}$
   What percentage of chloride is present in the water if 26.7 mL of 0.30M is necessary to react with all of chloride in a 14.0 g sample?
   (A) 26.7(0.3)(1000)/35.5(14) (B) 26.7(0.3)(35.5)/1000(14) (C) 26.7 (35.5)/(0.3)(1000)(14) (D) 26.7(14) (0.3) /1000(35.5) (E) 26.7(14) /1000 (0.3)(35.5)

6. Which of the following oxidizing titrants would most likely be used as its own indicator in acid solution?
   (A) H_2O_2 (B) $(NH_4)_2Ce(NO_3)_6$ (C) $K_2Cr_2O_7$ (D) $KMnO_4$ (E) I_2

7. For a sodium ion selective electrode, all of the following statement is true except:
   (A) the boundary potential depends upon the activities of both sodium and hydrogen ions. (B) the electrode is specific for sodium ion. (C) the potential is largely a function of the sodium ion activity. (D) the selectivity of the glass electrode is related to the cation exchange selectivity of the glass surface. (E) the sodium ions can penetrate the gel and influence the diffusion potential.

8. The excitation of outer electrons in atoms and molecule is associated with which of the following bands of radiation
   (A) Infrared (B) Gamma rays (C) Microwave and radio (D) Ultra violet (E) X-rays

9. Which of the following property is true for LASER except:
   (A) coherent (B) collimated (C) monochromatic (D) polarized (E) all of above

10. Considering isotopes of C^{12}, C^{13}; H^1, H^2; Cl^{35}, Cl^{37}; how many peaks (with minimum abundance > 1.0%) will be present in the mass spectrum of $CHCl_3$?
    (A) 5 (B) 6 (C) 7 (D) 8 (E) 9

11. The separation factor for a specific column is equal to the ratio of the:
(A) distribution coefficient (B) eddy diffusion (C) resolution (D) retention time (E) two of the above

12. Detector are often used in conjunction with chromatographic columns. They measure the separated solutes as they emerge. All of the features listed below are used in evaluating a detector except for
(A) linearity (B) mass flow rate (C) noise level (D) response time (E) stability

13. Which of the following is true for the behavior of lysine during electrophoresis? (Lysine $pk_1 = 2.16$, $pk_2 = 9.20$, $pk_3 = 10.80$)
(A) Lysine will migrate toward the negative electrode in a buffer of pH= 10.0
(B) Lysine will migrate toward the positive electrode in a buffer of pH= 10.0
(C) Lysine will migrate toward the positive electrode in a buffer of pH= 3.0
(D) Lysine will not migrate in a buffer of pH= 10.0 (E) Lysine will not migrate in a buffer of pH= 2.0

14. A student would like to separate the various components of a sample of ink in the laboratory. Which of the following techniques would be most suitable for him to use?
(A) chromatography (B) distillation (C) evaporation (D) filtration (E) fractional crystallization

15. Which of the following mass analyzer provides highest mass resolution?
(A) ion trap (B) magnetic sector (C) orbitrap (D) quadrupole (E) time of flight