注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 110 學年度碩士班考試入學試題

系所班組別：分析與環境科學研究所

科目代碼：2901

考試科目：分析化學

－作答注意事項－

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「▛ 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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考試科目（代碼）：分析化學(2901)

1. (5%) A new automated procedure for determining glucose in serum (Method A) is to be compared with the established method (Method B). Both methods are performed on serum from the same six patients to eliminate patient-to-patient variability. Do the following results confirm a difference in the two methods at the 95% confidence level?

Glucose (mg/L)	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Method A	1044	720	845	800	957	650
Method B	1028	711	820	795	935	639
Difference	16	9	25	5	22	11

(To answer this question, please refer to the statistics table at the bottom of this page)

2. (5%) The analysis of a calcite sample yielded CaO percentages of 55.95, 56.00, 56.04, 56.08, and 56.23. The last value appears anomalous; should it be retained or rejected at the 95% confidence level?

(To answer this question, please refer to the statistics table at the bottom of this page.)

Values of *t*

Degrees of Freedom	3	4	5	6	7	8	9	10
95%	3.18	2.78	2.57	2.45	2.36	2.31	2.26	2.23

Critical values for Q

Number of Observations	3	4	5	6	7	8	9	10
95%	0.970	0.829	0.710	0.625	0.568	0.526	0.493	0.466

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3. (10%) A 0.9092-g sample of a wheat flour was analyzed by the Kjeldahl method. The ammonia formed was distilled into 50.00 mL of 0.05063 M HCl; a 7.46-mL back-titration with 0.04917 M NaOH was required. Calculate the percent of protein in the flour. (Note: The nitrogen-to-protein conversion factor for cereals is 5.7)

4. (4%) What types of species can be separated by HPLC but not by GC?

5. (5%) Describe the working principle of quadrupole mass analyzer.

6. (6%) How does gas-liquid chromatography work? List the variables that lead to band broadening in gas-liquid chromatography.

7. (3%) Indicate the order in which the following compounds wound be eluted from an HPLC column containing a reversed-phase packing: acetone, dichloroethane, acetamide.

8. (4%) Why is atomic emission more sensitive to flame instability than atomic absorption or fluorescence?

9. (4%) Explain the working principle of the cold vapor atomic absorption spectroscopy to determine mercury.

10. (8%) What is the purpose of an internal standard in ICP-MS? List the characteristics that are often cited as requirements for a good internal standard.

11. (4%) Explain why molecular fluorescence often occurs at a longer wavelength than the exciting radiation.

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12. (5%) Quinine in a 2.196-g tablet was dissolved in a sufficient 0.10 M HCl to give 1.000 L. Dilution of a 20.00-mL aliquot to 100 mL gave a solution with a reading of 540 at 347.5 nm. A second 20.00-mL aliquot was mixed with 10.0 mL of 50 ppm quinine solution before dilution to 100 mL. The fluorescence intensity of this solution was 600. Calculate the concentration in parts per million of quinine in the tablet.

13. (5%) (a) Describe the working principle of voltammetry. (b) Suggest how the Equation list below could be employed to determine the number of electrons involved in a reversible reaction at a voltammetric electrode.

$$E_{\text{appl}} = E_{1/2} - \frac{0.0592}{n} log \frac{i}{i_l - i}$$

14. (5%) A photometer with a linear response to radiation gave a reading of 837 mV with a blank in the light path and 333 mV when the blank was replaced by an absorbing solution. Calculate (a) the transmittance and absorbance of the absorbing solution. (b) the transmittance to be expected if the light path through the original solution is doubled.

15. (7%) (a) Describe the source of pH-dependence in a glass membrane electrode. (b) The cell

SCE||H^+ $(a = x)$ | glass electrode

has a potential of 0.2094 V when the solution in the right-hand compartment is a buffer of pH 4.006. The following potential is obtained when the buffer is replaced with an unknown solution: -0.2910 V. Calculate the pH and the hydrogen ion activity of the unknown solution.

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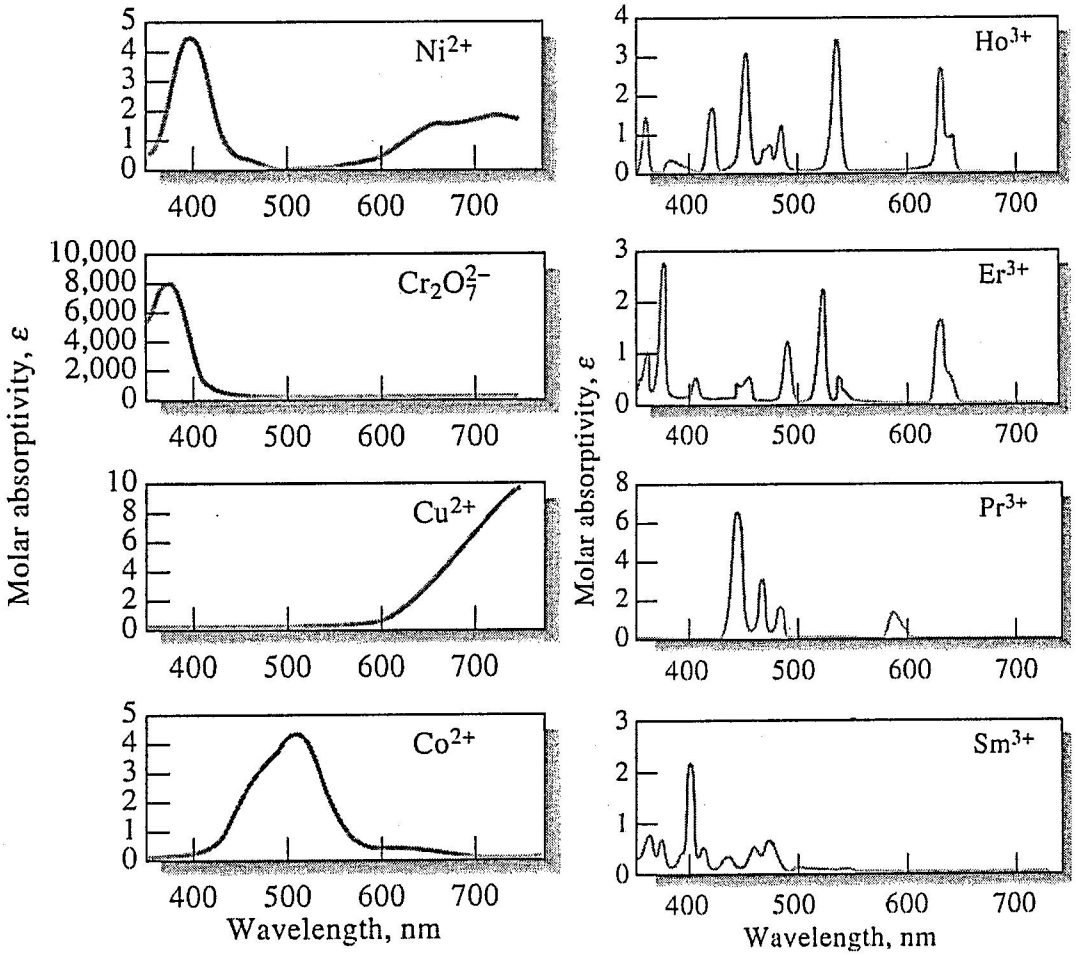
16. (5%) Following two figures are the absorption spectra of transition and rare earth ions. Apparently, these two spectra differ substantially from each other. Please state the reason why the absorption spectra of transition and rare earth ions are different.



17. (5%) (a) What are the structural characteristics of a chelating agent? (b) Why are multidentate ligands preferable to unidentate ligands for complexometric titration?

18. (10%) How would you prepare 1.0 L of a buffer with a pH of 9.45 from 0.3 M Na_2CO_3 and 0.2 M HCl? (Na_2CO_3: $K_{a1} = 1.5\times10^{-4}$, $K_{a2} = 4.69\times10^{-11}$)