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 112 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：2902
考 試 科 目：環境化學

─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。

1. Please define and/or explain the following terms. (30%, 5% for each)

    (A) Coagulation and flocculation.

    (B) Colloidal particles and Tyndall effect.

    (C) Extractive and renewable resources.

    (D) Stratification of the atmosphere based on temperature, density as well as physical and photochemical processes in air.

    (E) Chemoheterotrophs and chemoautotrophs.

    (F) Greenhouse gases and global warming potential.

2. Please answer the following questions. ·

    (A) A medium having $[HCO_3^-]$ = 5.00 x 10^{-3} M was collected and treated with sodium nitrilotriacetate. Please calculate the $[PbT^-]/[HT^{2-}]$ ratio as sodium nitrilotriacetate in equilibrium with $PbCO_3$. (8%)

    (B) If the medium in problem (A) contained excess calcium such that the concentration of uncomplexed calcium, $[Ca^{2+}]$, were 2.00 x 10^{-3} M, what would be the $[PbT^-]/[CaT^-]$ ratio at a pH of 5? (7%)

3. Zero point of charge (ZPC) is one of the important parameters depicting the surface properties of colloidal particles.

    (A) What is the definition of ZPC when applied to colloids? (5%)

    (B) Please define the terms of aggregation, sedimentation and suspension in terms of ZPC. (5%)

4. A 210.0-L sample of waste air from a smelter process was collected at 1 atm, 25°C, and the sulfur dioxide contamination was removed. After SO_2 removal, the volume of the air sample was 199 L. What was the percentage by weight of SO_2 in the original sample? (10%)

5. List and discuss some of the important processes determining the transformations and ultimate fates of hazardous chemical species in the hydrosphere. (10%)

6. A lake water is stratified to be both aerobic and anaerobic and it always contains several trace metal species including copper. The standard reduction potential of Copper(II) to Copper(I) is 0.16 V.

   (A) Calculate the ratio of Cu^{2+} to Cu^+ at a pE of -4 and at a pE of 14. (6%)

   (B) Which oxidation state of copper ions would you expect to dominate under anaerobic conditions? (3%)

   (C) Assuming that oxygen determines the electron availability near the surface of a lake, how would the decrease in pH affect pE? (3%)

   (D) Calculate the ratio of Cu^{2+} to Cu^+ ions available at a pH of 5 near the surface. (3%)

7. "Cat clays" are soils containing a high level of iron pyrite, FeS_2.

   (A) What is the indicator of acidity for Cat clays? (5%)

   (B) Please describe how to test the acidity of cat clays, and suggest the chemical reaction involved. (5%)

Note:

1. The atomic masses of elements are as follows:

H= 1.0	C= 12.0	N= 14.0	O= 16.0	Ca= 40.0
Na= 23.0	Mg= 24.3	Al= 27.0	Si= 28.1	S= 32.1
Cl= 35.5	K= 39.1	Fe= 56.0		

2. The equilibrium constants of reactions are as follows:

   $PbCO_3(s) \leftrightarrow Pb^{2+} + CO_3^{2-}$ $K_{sp} = 1.48 \times 10^{-13}$

   $Pb^{2+} + T^{3-} \leftrightarrow PbT^-$ $K_f = 2.45 \times 10^{11}$

   $H_3T \leftrightarrow 3H^+ + T^{3-}$ $K_{a1} = 2.18 \times 10^{-2}$

        $K_{a2} = 1.12 \times 10^{-3}$

        $K_{a3} = 5.25 \times 10^{-11}$

   $CO_2 + H_2O \leftrightarrow CO_3^{2-} + 2H^+$ $K_{a1} = 4.45 \times 10^{-7}$

        $K_{a2} = 4.69 \times 10^{-11}$

   $Ca^{2+} + HT^{2-} \leftrightarrow CaT^- + H^+$ $K = 7.75 \times 10^{-3}$