

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 114 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：3002

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。

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\*請在【答案卷】作答

1. Please define or explain the following terms. (30%, 6% for each)
  - (A) Photochemical processes in environmental chemistry.
  - (B) Carbon neutrality, net zero carbon emission and net zero emission.
  - (C) Capacitive deionization and reverse osmosis.
  - (D) Eutrophication and BOD.
  - (E) Micelle and critical micelle concentration
2. Match each organic pollutant with its expected effect listed below and explain the reasons. (15%, 5% for each)

Organic Pollutants

  - (A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$  (n-Hexane)
  - (B)  $\text{HCHO}$  (Formaldehyde)
  - (C)  $\text{CH}_3\text{-S-CH}_3$  (Dimethyl sulfide, DMS)

Expected Effects

  - I. Most likely to have a secondary effect in the atmosphere
  - II. Least likely to have a significant atmospheric effect
  - III. Most likely to have a direct atmospheric effect
3. With increasing concerns about global warming, the regulation of greenhouse gas emissions and usage has become increasingly stringent. Please address the following questions:
  - (A) Define the term "global warming potential (GWP)" and explain its significance. (5%)
  - (B) Why are chlorofluorocarbons (CFCs), such as  $\text{CF}_2\text{Cl}_2$  and  $\text{CFCl}_3$ , considered highly effective greenhouse gases? (5%)
  - (C) Provide an explanation of the concept of "positive feedback" in the context of the greenhouse effect. (5%)
4. A 200 mL river water sample is titrated with 14.61 mL of  $1.97 \times 10^{-2}$  M HCl to a pH of 4.3. Please answer the following questions:
  - (A) Calculate the total alkalinity of the sample. (4%)
  - (B) Determine the carbonate-to-bicarbonate ratio in the original sample at a pH value of 7.0.  
( $K_{a1}(\text{H}_2\text{CO}_3) = 4.3 \times 10^{-7}$ ;  $K_{a1}(\text{H}_2\text{CO}_3) = 5.6 \times 10^{-11}$ ) (4%)
  - (C) Calculate the concentration of the carbonate ion in the original sample. (4%)
  - (D) Identify the dominant ion that accounts for most of the alkalinity in the water sample. (3%)

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5. The water entering a purification plant has a hardness of 12 mg/L in terms of calcium carbonate ( $\text{CaCO}_3$ ) equivalent. Please address the following:
- (A) What is the total concentration of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions in mol/L? (5%)
  - (B) Assuming  $[\text{Ca}^{2+}] = [\text{Mg}^{2+}]$  and that bicarbonate ions are available, what is the minimum mass of sodium hydroxide (NaOH) required to precipitate all  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions in this water sample? (5%)
6. Cadmium is a highly toxic heavy metal that is poorly absorbed by the human body, with only 2-6% of ingested cadmium being taken up. Once in the body, it tends to accumulate in the liver and kidneys with a long half-life of about 21 years. Please respond to the following:
- (A) If a 75 kg individual needs to maintain a body concentration of cadmium at 700 ppb, calculate the required daily absorption of cadmium. (5%)
  - (B) The acceptable daily intake for cadmium from food sources is  $1 \times 10^{-3} \text{ mg kg}^{-1} \text{ day}^{-1}$ . For a 75 kg person, determine the maximum acceptable daily intake of cadmium. (5%)
  - (C) Exposure to cadmium concentrations well above 700 ppb can cause significant health issues. Given the values calculated in parts (a) and (b), assess whether the acceptance daily intake provided in part (b) offers sufficient protection against the risks of cadmium toxicity. (5%)