

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：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。

# 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

考試科目（代碼）：環境化學(2902)

共 2 頁，第 1 頁

\*請在【答案卷】作答

1. Please define or explain the following terms. (30%, 5% for each)
  - (A) Endogenic and exogenic cycles.
  - (B) Zeta potential.
  - (C) Ionic strength and adsorption.
  - (D) Terpene and photochemical smog.
  - (E) Carbon footprint.
  - (F) Chelation.
2. What is the settling velocity of a particle with a Stokes diameter of  $7\text{ }\mu\text{m}$  and a density of  $1\text{ g/cm}^3$  in air at 1.00 atm and  $25\text{ }^\circ\text{C}$ ? (The viscosity of air at  $25\text{ }^\circ\text{C}$  is 186 micropoise. The density of air under 1.00 atm and  $0\text{ }^\circ\text{C}$  is  $1.29\text{ g/L}$ .) (20%)
3. A river water was sampled and analyzed in laboratory, and having a total alkalinity of  $1.5 \times 10^{-3}$  equivalents/liter with a pH of 6.8.
  - (A) Calculate the concentration of  $\text{CO}_{2(\text{aq})}$ ,  $\text{HCO}_3^-$ ,  $\text{CO}_3^{2-}$  and  $\text{OH}^-$ . (5%)
  - (B) Assume no input of atmospheric  $\text{CO}_2$ . Through the photosynthetic activity of algae, the pH of the water was changed to 10.0; please calculate all the preceding concentrations and the weight of biomass,  $\{\text{CH}_2\text{O}\}$ , produced. (10%)
4. Humic substances have recently received much attention in environmental chemistry. It can be used as complexing agents to sorb heavy metals and organics, and serve as electron mediators to enhance the degradation rate of environmental pollutants and the reductive dissolution of ferric oxides in soil and sediments. The possible reason is the versatile functional groups in their structures. Please answer the following questions:
  - (A) The possible formation mechanisms of humic substances. (7%)
  - (B) Usually humic substances can be divided into humic acid, fulvic acid and humin according to the solubility in acid and base. Please compare the general properties of humic acid and fulvic acid (e.g. molecular weights, functional groups and elemental composition). (8%)
  - (C) Briefly describe the principles of electron shuttling effect of humic substances. (5%)

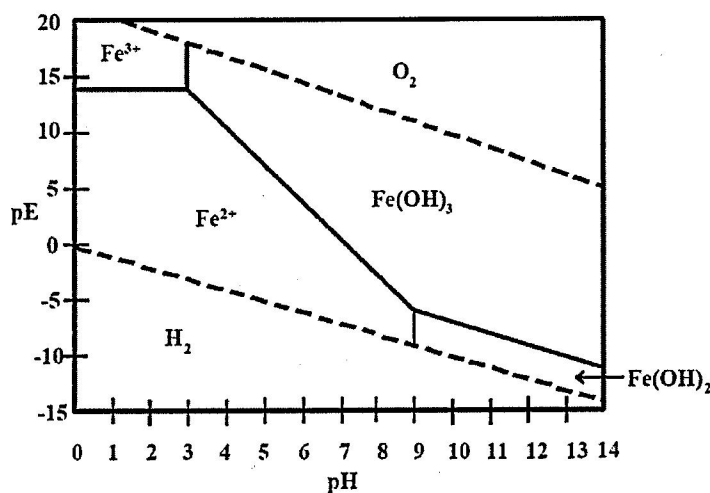
# 國立清華大學 110 學年度碩士班考試入學試題

系所班組別：分析與環境科學研究所

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共 2 頁，第 2 頁 \*請在【答案卷】作答

5. pE-pH diagram is a useful tool to predict chemical state of species in water. The following figure is a typical pE-pH diagram for iron in water at the total soluble iron concentration of  $1 \times 10^{-5}$  M.



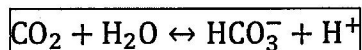
- (A) Calculate the values of  $[\text{Fe}^{3+}]$ , pE, and pH at the point in following figure where  $\text{Fe}^{2+}$  is at a concentration of  $1 \times 10^{-5}$  M, and  $\text{Fe}(\text{OH})_2$  and  $\text{Fe}(\text{OH})_3$  are all in equilibrium. (10%)
- (B) Please describe the electrochemical meaning of two dash lines in pE-pH diagram and explain the origin of slope of those dash lines. (5%)

Note:

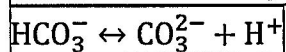
1. The atomic masses of elements are as follows:

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					

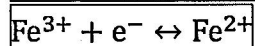
2. The equilibrium constants or pE of reactions are as follows:



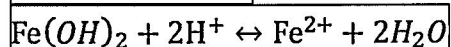
$$K_{a1} = 4.45 \times 10^{-7}$$



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



$$\text{pE}^0 = 13.2$$



$$K_{sp} = 8.0 \times 10^{-12}$$