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 113 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：2802

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 113 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碩士班

考試科目（代碼）：環境化學(2802)

1. Please define the following terms and elucidate their potential effects on humans or the environment, if applicable. (30%, 5% for each)
   (a) Endocrine disruptors
   (b) Permanent gases
   (c) Life cycle assessment
   (d) Refractory and biorefractory organics
   (e) The aerobic degradation process of organic matter
   (f) Chromatography

2. Both ozone depletion and the emission of greenhouse gases contribute to global climate change. Professor Pyle at the University of Cambridge in England has proposed that ozone destruction in the late spring over northern latitudes may be initiated in the lower stratosphere by the photolysis of $ClONO_2$ to Cl and NO_3, followed by photolysis of the latter to NO and O_2. Deduce a catalytic ozone destruction cycle, requiring no atomic oxygen, that incorporates these reactions. Please answer the following questions.
   (a) What is the overall reaction of a catalytic ozone destruction cycle? (3%)
   (b) One of the reasons of ozone destruction is the use of chlorofluorocarbons (CFCs) as solvents and refrigerants. The average bond enthalpies for C-F and C-Cl are 484 kJ mol^{-1} and 338 kJ mol^{-1}, respectively. Calculate the maximum wavelength of light required to break each of these bonds. (6%)
   (c) Can CFCs undergo photodissociation in the troposphere? Please explain your reason. (6%)

3. To mitigate carbon dioxide emissions from power plants, contemporary facilities employ various strategies such as oxygen-enhanced combustion, chemical looping combustion, and carbon capture. However, besides carbon dioxide, NO_x, SO_x, and particulate matter also contribute significantly to gas pollutants. If a power plant burning 40,000 metric tons of coal per day with 10% excess air emits stack gas containing 125 ppm by volume of NO, what is the daily output of NO? Assume the coal is pure carbon. (10%)

4. Explain the concept of "end-of-pipe" measures for pollution control, providing an example if applicable. Discuss the reasons for the necessity of such measures and why they are considered less preferable. Additionally, explore alternative approaches to pollution control. (15%)

5. For a lake water having a total alkalinity of 1×10^{-3} eq/L (contributions from HCO_3^-, CO_3^{2-} and OH^-) at a pH value of 10.3, what is the percentage contribution to alkalinity from CO_3^{2-}? (10%)

6. The standard drinking water treatment process includes multiple stages to guarantee the quality of drinking water. These stages commonly encompass coagulation and flocculation, sedimentation, filtration, and pH adjustment. Additionally, an aeration process is typically employed for groundwater treatment. Aeration holds significant importance in the purification of drinking water as it promotes the oxidation of water-soluble Fe^{2+}, leading to the formation of solid precipitates that can be subsequently removed.
   (a) Under what pH conditions is the removal of iron typically favored? (5%)
   Hint: The $K_{sp}(Fe(OH)_3) = 2.0\times10^{-39}$
   (b) What is the maximum allowable residual amount of iron (ppm) in a thoroughly aerated water sample at pH 8.0? (7%)
   (c) Assume that the rate of oxidation from Fe^{2+} to Fe^{3+} is $7.2\times10^{13}[Fe^{2+}][OH^-]^2pO_2\ L^2\ mol^{-2}\ atm^{-2}\ min^{-1}$. What is the half-life of Fe^{2+} at the pH of 8.0? (8%)

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 Planck constant is equal to 6.625×10^{-34} Js.
3. The speed of light is equal to 3×10^8 m s^{-1}.
4. The Avogardo's number is equal to 6.023×10^8 mol^{-1}.