

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 115 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. 提早交卷者不可攜出試題，請將試題連同答案卷(卡)交予監考人員，攜出將以違規論處。當節考試結束後試題將置於講台，可自行取回，本試場不負保管責任。
7. 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）：環境化學（3002）

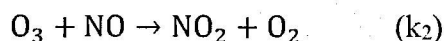
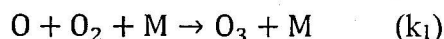
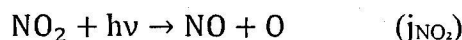
共 2 頁，第 1 頁

*請在【答案卷】作答

1. Please define and/or explain the following terms (25%, 5% for each)

- (A) Oxygen sag curve
- (B) Secondary minerals
- (C) Quantum yield
- (D) Cation exchange capacity
- (E) Polar stratosphere clouds

2. In the troposphere, the photochemical reaction between nitrogen oxides (NO_x ; mainly NO_2 and NO) and ozone (O_3) can be described as follows:



- (A) Define the pseudo-steady-state approximation (PSSA). In atmospheric chemistry, what types of reactive species are most suitable for applying this approximation? (5%)
 - (B) Assuming atomic oxygen (O) is a pseudo-steady-state species, apply the pseudo-steady-state approximation (PSSA) to derive an expression for its concentration, $[\text{O}]$. (10%)
3. Manganese plays an important role in natural waters as both Mn^{2+} and $\text{MnO}_2(\text{s})$. At temperature of 25°C , $\text{pH} = 7.0$, and activity of $\text{Mn}^{2+} = 1.0 \times 10^{-5}$. Please answer the following questions.
- (A) Calculate the pe of the solution assuming the $\text{Mn}^{2+}/\text{MnO}_2$ system is at equilibrium. (10%)
 - (B) Suppose a natural water sample has a dissolved oxygen concentration of 0.2 mM at $\text{pH} 7.0$. Calculate the minimum concentration of Mn^{2+} required for $\text{MnO}_2(\text{s})$ to precipitate under equilibrium conditions with O_2 . (12%)
4. Air pollution causes the problem of acid rain. Generally, when the pH of rainwater is below 5.6 , it is considered acid rain. Please calculate and explain the reason why. (Assume the CO_2 concentration in the atmosphere is $10^{-3.5} \text{ atm}$). (10%)

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5. Please complete the following questions regarding the logarithmic concentration diagram.
- (A) Draw a logarithmic concentration diagram for a 10^{-4} M solution of hypochlorous acid (25°C). (10%)
- (B) From the diagram obtained in part(A), determine the equilibrium pH for 10^{-4} M hypochlorous acid. (5%)
- (C) From the diagram obtained in part(A), determine the equilibrium pH after 10^{-4} mol of NaOH has been added to a liter of solution. (5%)
6. Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic chemicals that have received increasing environmental concern in recent years due to their persistence, bioaccumulation, and potential toxicity. PFAS have varying carbon chain lengths and are widely used in industry and consumer products. The most representative PFAS are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS).
- (A) Describe three common industrial or consumer applications of PFAS. (3%)
- (B) Draw the chemical structure of PFOA. (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 E^0 of reactions are as follows:

