

國立清華大學 100 學年度碩士班入學考試試題  
系所班組別：生醫工程與環境科學系 乙組 (環境分子科學組)  
考試科目 (代碼)：環境化學 (2605)

共 2 頁，第 1 頁 \*請在【答案卷、卡】作答

1. Please define or explain the following terms: (30%)
  - (a) Anthropocene
  - (b) Chelation
  - (c) Intrinsic solubility
  - (d) zero point of charge (ZPC):
  - (e) radiative forcing
  - (f) Recarbonation
2. (a) What two chemical species are most generally responsible for the removal of hydroxyl radical from the unpolluted troposphere? (5%)  
(b) Using numbers ranging from 1 to 4, put the following in order of their anticipated lifetime in the troposphere, from the longest-lived (1) to the shortest-lived (4), and explain:  $\text{SO}_2$ ,  $\text{CClF}_3$ ,  $\text{O}^*$ , and  $\text{CH}_4$  (5%)
3. The average bond enthalpies of C-F and C-Cl are 484 and 338  $\text{kJ mol}^{-1}$ , respectively.
  - (a) Calculate the maximum wavelength of light required to break each of these bonds. (5%)
  - (b) Can CFCs photodissociate to an appreciable extent in the troposphere? Please explain your reason. (5%)  
(hint: Planck constant:  $6.625 \times 10^{-34}$  Js)
4. Consider the following aqueous route to oxidize  $\text{SO}_2$ :  
 $\text{SO}_{2(\text{aq})} + \text{H}_2\text{O}_{2(\text{aq})} \rightarrow \text{H}_2\text{SO}_{4(\text{aq})} \quad k = 1.1 \times 10^3 \text{ L mol}^{-1} \text{ s}^{-1}$ 
  - (a) The partial pressures and Henry's Law constants for  $\text{SO}_2$  and  $\text{H}_2\text{O}_2$  are 3.0 ppm ( $K_H = 1.2 \text{ mol L}^{-1} \text{ atm}^{-1}$ ) and 4.0 ppb ( $K_H = 1.0 \times 10^5 \text{ mol L}^{-1} \text{ atm}^{-1}$ ), respectively. Calculate the reaction rate of this process. (7%)
  - (b) Calculate the reaction rate (per liter of air) if the amount of liquid water in the atmosphere is  $0.014 \text{ g L}^{-1}$ . (6%)

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5. A sediment sample was taken from a lignite strip-mine pit containing highly alkaline (pH10) water. Cations were displaced from the sediment by treatment with HCl. A total analysis of cations in the leachate yielded, on the basis of millimoles per 150 g of dry sediment, 250 mmol of  $\text{Na}^+$ , 10 mmol of  $\text{K}^+$ , 20 mmol of  $\text{Mg}^{2+}$ , and 75 mmol of  $\text{Ca}^{2+}$ . What is the cation exchange capacity of the sediment? Why does  $\text{H}^+$  not have to be considered in this case? (10%)
6. A 200.00 mL water sample is titrated with 14.61 mL of  $1.97 \times 10^{-2}$  M HCl to pH 4.3.
- (a) Calculate the total alkalinity of the sample. (3%)
- (b) What is the carbonate to bicarbonate ratio in the original sample at pH 7.0?  
(Hint:  $K_{a2}(\text{H}_2\text{CO}_3) = 5.6 \times 10^{-11}$ ) (3%)
- (c) What is the concentration of carbonate ion in the original sample? (3%)
- (d) What is the dominant ion that accounts for most of the alkalinity in this water sample? (3%)
7. One of the benefits of aeration in purification of drinking water is that it oxidizes watersoluble  $\text{Fe}^{2+}$ .
- (a) What pH conditions would favor removal of iron? ( $K_{sp}(\text{Fe}(\text{OH})_3) = 2.0 \times 10^{-39}$ ) (5%)
- (b) What is the maximum residual amount of iron (ppm) that could be present in a thoroughly aerated water sample at pH 8.0? (5%)
- (c) Assume that the rate of oxidation from  $\text{Fe}^{2+}$  to  $\text{Fe}^{3+}$  is given by the equation below. What is the half-life of  $\text{Fe}^{2+}$  at pH 8.0? (5%)
- $$\text{Rate} = 7.2 \times 10^{13} [\text{Fe}^{2+}] [\text{OH}^-]^2 p(\text{O}_2) L^2 \text{ mol}^{-2} \text{ atm}^{-1} \text{ min}^{-1}$$

Note: 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	S = 32.1	Cl = 35.5	K = 39.1	Fe = 56.0	F = 19.0