

國立清華大學 105 學年度碩士班考試入學試題
系所班組別：生醫工程與環境科學系 乙組 (環境與分子科學組)
考試科目 (代碼)：環境化學 (2202)

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- (a) What the source of nitrate in groundwater? (15%)

(b) Explain why excess nitrate in drinking water or food products can be a health hazard.

(c) The nitrate concentration in an aquifer is 20 ppm and its volume is 10 million liters. What mass of ammonia upon oxidation would have produced this mass of nitrate?
- (a) From what medium – air, food, or water – does most human exposure to dioxin come about? Why is this so?

(b) Not all dioxin congeners equally toxic. What pattern of chlorine substitution leads to the greater toxicity? What is the most toxic dioxin?

(c) Predict the order of relative toxicities of the following three dioxin congeners,
2,3,7- trichlorodibenzo-p-dioxin
1,2,3- trichlorodibenzo-p-dioxin
1,2,3,7,8- pentachlorodibenzo-p-dioxin (15%)
- (a) Many of the species in the stratosphere have a loosely bound oxygen atom. Which of the following species do(es) not contain a loose oxygen?
HOO·, OH·, NO·, O₂, ClO·

(b) Why aren't gases such as CF₂Cl₂ (a CFC) readily oxidized in the troposphere? Would the same be true for CH₂Cl₂? (10%)
- How much HOCl (pK_a = 7.6) must be added to pour water to make a solution of pH 4.3? pH6.5? (10%)
- Write the proton condition for the following system. (10%)

(a) 10⁻³ M Na₃PO₄ + 10⁻⁴ M Na₂HPO₄, using PO₄³⁻ as the basis species.

(b) Same system as in (a), using HPO₄²⁻ as the basis species.

6. An orange paint is colored by a mixture of red lead (Pb_3O_4) and school bus yellow (PbCrO_4), and contains 16.18% Pb by weight.
- What is the maximum amount (g) that you could put into a swimming pool (3m x 5m x 8m) to ensure that any lead leached into the water would remain below the WHO drinking water standard for lead of 10 ppb?
 - If the paint contains 2.32% Cr by weight, calculate the relative ratio of Pb_3O_4 and PbCrO_4 . (20%)

7. Natural organic matter (NOM) can enter water supplies as a result of biological reactions in the water (e.g., release of algal and other microbial metabolic products) or by leaching of organic molecules released by degradation of terrestrial plants in the watershed. Many of these NOM molecules are acidic and water that contains NOM and low concentrations of dissolved inorganic species can be quite corrosive to drinking water distribution systems. One approach to overcoming this problem is to contact the water with limestone (CaCO_3). This process causes some CaCO_3 to dissolve, neutralizing some of the acidity of the water and increasing its buffer intensity.

Assume that the NOM molecules in a particular water supply can be represented as diprotic acids with $\text{pK}_{a1} = 4.8$ and $\text{pK}_{a2} = 7.7$, and that they have an average molecular weight of 250. The water, which can be represented as a mixture of water, and H_2NOM initially, is treated in a limestone contactor. The water exiting the contactor contains 4.5 mg/L Ca^{2+} and is at pH 7.9. Estimate (a) the NOM concentration and (b) the alkalinity (defined by titration to pH 4.5) of the treated water, expressing the former as milligrams NOM per liter and the latter as milligrams per liter as CaCO_3 . (20%)

Note: The atomic masses of elements are as follows:

H = 1.0	C = 12.0	N = 14.0	O = 16.0	Ca = 40.0	Pb = 207.2
Cr = 52	P = 31.0	Cl = 35.5	Na = 23.0		