

國立清華大學 103 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 (2405)

共 3 頁，第 1 頁 *請在【答案卷、卡】作答

1. Please define the following chemicals and explain their impacts on human or environment. (20%)
 - (a) Endocrine disruptors (Environmental Estrogens)
 - (b) Persistent organic pollutants:
 - (c) Polycyclic aromatic hydrocarbons
 - (d) Chlorofluorocarbons

2. A 50.0 mL water sample is titrated with 0.0113 M EDTA at pH 10 using calmagite indicator. Upon addition of 18.13 mL of EDTA solution the blue calmagite turns an intense red color. Report the hardness of this water sample in ppm of an equivalent amount of calcium carbonate. (10%)

3. A common source of metal lead is the mineral *galena* (PbS). Lead has many useful properties and the PbS itself also has many uses including glazing earthenware, in making electronic components (like photoresistors in infrared radiation detectors), as a hydrodesulfurization catalyst in petroleum refining and as a friction additive.
 - a. Write down the chemical equation for the reaction of lead sulfide with acid (H^+) in an aqueous system.
 - b. Given that the solubility product of lead sulfide is 8.0×10^{-28} and the second dissociation constant (K_{a2}) of hydrogen sulfide is 1.3×10^{-13} , calculate the solubility of lead sulfide at a pH of 12 and at a pH of 3.
 - c. What effect would acid mine drainage have on the water systems near a galena mine? Is this consistent with your results in Part (b)? (15%)

4. Hypochlorous acid has about 80 times more disinfectant power than the hypochlorite ion. In relative amounts, how much more sodium hypochlorite must be added to water at pH 8.0 to have the same disinfecting power as sodium hypochlorite in water at pH 7? ($K_{a(HOCl)} = 2.7 \times 10^{-8}$) (10%)

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共 3 頁，第 2 頁 *請在【答案卷、卡】作答

5. The minimum pressure required to force particles through a semi-permeable membrane is described by an equation very similar to the ideal-gas law:

$$\pi V = nRT$$

where the product of osmotic pressure (π) and solution volume (V) equals the moles (n) of particles in that volume times the ideal gas constant (R) and temperature (T).

- a. At 22°C glucose ($C_6H_{12}O_6$) has an osmotic pressure of 7.0 atm. What is the maximum concentration of glucose that can be forced through a membrane at 7.0 atm?
 - b. A 0.1 M solution of NaCl has twice the osmotic pressure as a 0.1 M solution of glucose. Why?
 - c. Calculate the minimum pressure required to have a 0.1 M solution of $CaCl_2$ undergo reverse osmosis at 25°C. (15%)
6. Approximately 2 – 6% of ingested cadmium is actually absorbed by the human body. Once incorporated in the body, cadmium concentrates mostly in the liver and kidneys, and has a whole body half-life of about 21 years.
- a. How much cadmium must be absorbed daily to maintain a 700 ppb level in an 80 kg person?
 - b. The ADI (RfD) of cadmium for food is $1 \times 10^{-3} \text{ mg kg}^{-1} \text{ d}^{-1}$. What is the acceptable daily intake of cadmium for an 80 kg person?
 - c. A whole body concentration of cadmium much greater than 700 ppb can cause health problems. Is the ADI (RfD) stated in Part (b) reasonable? (15%)

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7. (a) Please define the term of toxicity equivalency factor (TEQ).
 (b) Using the TEQ values listed in Table 1, calculate the number of equivalent picograms of 2,3,7,8-TCDD that correspond to an intake of 24pg of 1,2,3,7,8,9-hexachlorodibenzo-p-dioxin, 52 pg of 2,3,4,7,8-pentachlorodibenzo-furan, and 200 pg of octachlorodibenzofuran.
 (c) Using the TEQ values listed in Table 1, identify whether Mixture A (9wt.% of 2,3,4,7,8-PCDF, 45wt.% of 1,2,3,4,6,7,8-HCDD, 46wt.% of 2,3,7,8-TCDF) or Mixture B (5wt.% of 1,2,3,7,8-PCDD, 32wt.% of 1,2,3,7,8,9-HCDF, 63wt.% of 2,3,7,8-TCDF) is more toxic. What are the relative toxicities of A and B?

Table 1 Toxicity Equivalence Factors (TEQ) for some important chemicals

Chemicals	TEQ
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.5
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,4,6,7,8-Hexachlorodibenzo-p-dioxin	0.01
Octachlorodibenzo-p-dioxin	0.001
2,3,7,8-Tetrachlorodibenzofuran	0.1
2,3,4,7,8-Pentachlorodibenzofuran	0.5
1,2,3,7,8-Pentachlorodibenzofuran	0.05
1,2,3,4,7,8-Hexachlorodibenzofuran	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.01
Octachlorodibenzofuran	0.001

(15%)

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 Cu = 64.0 F = 19.0
 Cd = 112.4 Pb = 207.2