

系所組別： 環境工程學系甲組

考試科目： 環境化學及環境微生物學

考試日期： 0225，節次： 2

**Problem Sets for Environmental Chemistry**

1. **Equilibrium Chemistry.** Un-ionized hydrogen cyanide (HCN) is toxic to fish. Assuming that the toxic level of HCN for a given species of fish is  $10^{-6}$ M. For a total cyanide concentration of  $10^{-3}$ M, determine at what pH HCN reaches toxic levels for (a) ionic strength approximately 0 (b) ionic strength = 0.1 M. (HCN  $K_A = 4.8 \times 10^{-10}$ ) (15 pts)
2. **Solubility.** Anthracene has contaminated harbor sediments, and the solid portion of sediments is in equilibrium with the pore water. If the organic content of sediments is 5 % and the solid sediment anthracene concentration is 50  $\mu\text{g}/\text{kg}$  sediment, what is the pore water concentration of anthracene at equilibrium? Assuming that the soil-water partition coefficient normalized to organic carbon is 4.32 (log  $K_{oc}$ ). (15 pts).
3. **Chemical Reaction Kinetics.** A lake's water quality has been diminished because of high hydrogen sulfide concentrations. To combat the problem, it is suggested to aerate the lake in an attempt to oxidize the odorous hydrogen sulfide to sulfate. It has been determined experimentally that the reaction,  $\text{H}_2\text{S} + 2\text{O}_2 \rightarrow \text{SO}_4^{2-} + 2\text{H}^+$ , follows first-order kinetics with respect to both oxygen and hydrogen sulfide concentrations. The present rate of aeration maintains the oxygen concentration in the lake at 2 mg/L. The rate constant  $k$  for the reaction was determined to be 1000 L/mole/day. If the aeration completely inhibited anaerobic respiration and thus stopped the production of sulfide, how long would it take to reduce the hydrogen sulfide concentration in the lake from 500  $\mu\text{m}$  to 1  $\mu\text{m}$ ? (10 pts).
4. **Indoor Air Quality.** The Taiwan EPA recently starts to regulate indoor air quality for certain public areas. Please list 5 indoor air quality items regulated by the Taiwan EPA. (10 pts).

(背面仍有題目,請繼續作答)

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**Environmental Microbiology (50%)**

5. The bacteria have a chemically complex external covering, termed the cell envelope. It lies outside of the cytoplasm, and is composed of two main layers: the cell wall and the cell membrane.
- (a) Please contrast (illustrate graphically) the cell envelope structures of gram-positive and gram-negative bacteria. (10%)
  - (b) Do you think that the property of cell envelope is an important consideration for bacteria to degrade the petroleum hydrocarbon? Why? (5%)
6. Respiration and fermentation are the fueling processes by which chemotrophs can conserve the energy from the oxidation of organic or reduced inorganic compounds. During these catabolic reactions, adenosine triphosphate (ATP) is synthesized by either oxidative phosphorylation (respiration) or substrate-level phosphorylation (fermentation).
- (a) How does substrate-level phosphorylation differ from oxidative phosphorylation? (6%)
  - (b) Which form(s) of ATP synthesis requires cytoplasmic membrane participation? Why? (5%)
  - (c) Nitrification and denitrification are two respiration reactions. Please discuss their possible electron donors and terminal electron acceptors. (6%)
7. You have been hired to *in-situ* bioremediate a site in which the groundwater is contaminated with the chlorinated pollutants such as trichloroethene.
- (a) It is suggested that use of reductive dechlorination and bioaugmentation methods to the site may be feasible. Please describe what are the “reductive dechlorination” and “bioaugmentation” methods. (8%)
  - (b) What factors will you consider when attempting to stimulate the microbial degradation of trichloroethene anaerobically in this case? (10%)