※ 考生請注意：本試題不可使用計算機

Problem Sets for Environmental Chemistry

Equilibrium Chemistry. Calculate the ratio of HOCl and OCl^-. In solutions with following pH values (a) 6.0 (b) 7.0 (c) 8.0. The pKa for HOCl is 7.5. (10 pts)

Solubility. Atrazine is a common groundwater pollutant in the corn-producing regions. The log K_{ow} for atrazine is 2.65. Calculate the fraction of total atrazine that will be absorbed to the soil given that the soil has an organic carbon content of 2.5%. The bulk density of the soils is 1.25 g/cm3; this means that each cubic centimeter of soil (soil plus water) contains 1.25 g soil particles. The porosity of the soil is 0.4. (15 pts).

Reaction Kinetics. Due to a poor scheduling, students set up a CBOD test on the Monday before a holiday (initial D.O.= 9 mg/L). On the third day, the students measure a D.O. of 6 mg/L and mistakenly reaerate the sample so that the D.O. hoes up to 8 mg/L. They then go home for the holiday. After an 18-day interval, they return to school and measure the D.O. to be 3 mg/L. The original sample size was 6 mL and the total sample volume in the BOD bottle was 300 mL (the balance being dilution water). Assume that the ultimate CBOD was reached in 14 days and the $k_L = 0.1\ day^{-1}$. Calculate the 5-day ultimate CBOD of the sample. (15 pts).

Atmospheric Aerosol. Please clearly describe the definition of atmospheric aerosols, their formation mechanisms, and possible health impacts. (10 pts).

(背面仍有題目,請繼續作答)

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Environmental Microbiology (50%)

(1) Reactions below are responsible for the anaerobic conversion of propionate to methane and carbon dioxide, and mediated by bacterial and archaeal populations, respectively. Please discuss the microbial interactions possibly taking place between the three populations (10%).

Reactions	$\Delta G^{0'a}$ (kJ/mol)
Methanogenic reactions	
$4H_2 + HCO_3^- + H^+ \rightarrow CH_4 + 3H_2O$	−135.6
$4HCOO^- + H_2O + H^+ \rightarrow CH_4 + 3HCO_3^-$	−130.4
Syntrophic oxidations	
$Propionate^- + 3H_2O \rightarrow Acetate^- + HCO_3^- + H^+ + 3H_2$	+76.1

(2) Trichloroethene is a chlorinated pollutant commonly found in the groundwater. To clean up the trichloroethene pollution, the microbiological treatment approach, namely bioremediation can be used. The bioremediation technology can be involved in a co-metabolic mechanism under aerobic conditions, or a metabolic mechanism under anaerobic conditions. (a) Please define the "co-metabolism" scientifically (5 %), and (b) how to activate a co-metabolic process for degrading trichloroethene under aerobic conditions (5 %). (c) The metabolism of trichloroethene is usually referred to as a dehalorespiration. Please describe what the dehalorespiration is based on a microbial respiratory principle (5 %). (d) A "bioaugmentation method" can be applied to enhance the removal efficiency of trichloroethene during bioremediation. Please briefly describe the "bioaugmentation method" (5 %).

(3) A pure culture that only contains a single kind of microorganism can be obtained in many ways, such as the streak plate and liquid dilution methods. (a) Please describe how to combine these two methods to isolate a pure bacterial culture for degrading toluene aerobically from a toluene-contaminated soil sample (10 pts). (b) How do you confirm that the bacterial culture you obtain is "pure"? Please provide five criteria (10 pts).