

## 環境化學(50%)

1. The valency or oxidation number of an organic carbon atom is determined by the number of electrons that it can give up the combine with  $O_2$ , and convert to  $CO_2$  with complete oxidation. Please calculate out the COD (mg/L as  $O_2$ ) and TOC (mg/L as C) and the oxidation number (valency) of the following compounds.  
(1) Glucose, (2) Ethanol, (3) Urea with 1,000mg/L, respectively. (18%)
2. There are 3 organic group in the kitchen waste (garbage). These food residuals could be degraded to volatile fatty acids (VFA), ammonia, hydrogen sulfide and biogas by the anaerobic microorganisms. To write out at least 12 components. (12%)
3.  $CO_2$  emission is contributed to combustion of organic carbons. Mean times, the  $CO_2$  gas could be dissolved into water. To write out 3 hydrolytic ( $CO_2 + H_2O$ ) and dissociation equations. 2 ionization equilibriums of carbonate system shall be expressed with  $pK_{A1}=6.37$  and  $pK_{A2}=10.33$  which 2 components contribute to alkalinity. (10%)
4. Four kinds of heavy metal are used for COD examination analysis, Please write out their chemical function and formula. Is it harmful to the environmental health? (10%)

(背面仍有題目,請繼續作答)

## Problem Sets for Environmental Microbiology

5. **Diversity of Microbial Ecology** Please clearly describe, compare, and contrast physiological characteristics and their environmental significance of the following paired microorganisms:
- (1) *Nitrosospira* and *Nitrospira* (5 pt)
  - (2) *Methanosarcina* and *Methylobacterium* (5 pt)
  - (3) *Thiothrix* and *Desulfovibrio* (5 pt)
6. **Microbial ecology** In 1986, Andrews and Harris proposed a theory of r- and K-selection in ecology (**R-SELECTION AND K-SELECTION AND MICROBIAL ECOLOGY** ADVANCES IN MICROBIAL ECOLOGY 9: 99-147 1986). Please clearly explain what is the theory of r- and K-selection in ecology. Please also provide an example of this theory applied to microbiology in biological processes for water/wastewater/soil treatment. (8 pt)
7. **Mathematical models for microbiology.** Please clearly explain, compare, and contrast the models developed by L. Michaelis and M. Menten in 1913 and J. Monod in 1940s, respectively. (7 pt)
8. **Microbial growth kinetics under multiple substrates** Suppose that a particular microorganism's growth can be described using the multiplicative Monod model. Given the substrate concentration and kinetic coefficients below, what would its growth rate be? Would either of the substrates be considered limiting (using  $< 90\%$  of the maximum rate as the criteria)?  $S_1=25$  mg/L glucose,  $S_2=10$  mg/L ammonium-N,  $K_1=5$  mg/L glucose,  $K_2=0.5$  mg/L ammonium-N, maximum specific growth rate  $\mu = 6 \text{ day}^{-1}$ . (10 pt)
9. **Biological Nutrient Removal.** A wastewater with BOD = 120 mg/L, TKN 30 mg/L and total phosphorus = 12 mg-P/L. Sketch a treatment process flowsheet you might propose if (a) the phosphorus limitation is 1 mg/L and ammonia oxidation is required (5 pt). (b) to remove nitrogen to 2 mg-N/L and phosphorus to 1 mg-P/L (5 pt) (please provide explanations).