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：0307·節次：2

※ 考生請注意：本試題 □可 ☑不可 使用計算機

環境化學部分（ 50 %）

1. To calculate out TOC (as 12 g-C) and COD (as 32 g-O$_2$) concentration (mg/L) from 1 mole/L of the following compounds in water solution. Then to calculate out the COD/TOC ratio of each compound.

   (15 %)

		Atomic Weight
(1)	Ethanol, C_2H_5OH	C : 12
(2)	Acetone, CH_3COCH_3	O : 16
(3)	Oxalic acid, COOHCOOH	N : 14
(4)	Lactic acid, $CH_3CHOHCOOH$	H : 1
(5)	Urea, NH_2CONH_2	

2. To draw out the chemical structure of the priority pollutant compounds. (15 %)
   (1) TriChloroMethane (THM)
   (2) 2,3,7,8-Tetrachloro-Dibenzo-p-Dioxin (TCDD)
   (3) para-nitro-phenol (PNP)
   (4) Alkyl-Benzene Sulfonate (ABS, Sodium lauryl benzene sulfonate)
   (5) Ethylene Diamine Tetra Acetic acid (EDTA)

3. To write out the equilibrium equation of Acetic acid (CH3COOH) with the ionization constant pK_A: 4.74, then to illustrate the logarithmic concentration diagram (log C *vs* pH) for 0.01 M acetic acid.

   (10 %)

4. To explain the biochemistry of fatty acid degradation through Beta-oxidation with 5 steps of biochemical reactions.

   (10 %)

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Environmental Microbiology

5. **Nutrient cycle.**　　Please list three major reaction equations, the corresponding microbial populations and key enzymes in the nitrogen cycle. (15 pts)

6. **Phylogeny and Molecular tools.** In 1977, Carl Woese and Fox George proposed a "Three Domains of Life" concept for grouping the living organisms on Earth based on the sequences of small subunit ribosomal RNA (SSU rRNA) gene. This revolutionary concept together with advance of molecular biological tools has brought about a paradigm shift in microbiology and microbial ecology.
   (a) What is "Three Domains of Life"? (3pts)
   (b) What are the SSU rRNA molecules in the procaryotic and eucaryotic cells, respectively? (2pts)
   (c) Please discuss why the SSU rRNA gene sequences are suitable for phylogenetic analysis (10pts)
   (d) Please briefly describe three kinds of molecular tools that can be applied to link microbial identity with the function. (6pts)

7. **Energetics and Microbial interaction.**　　Anaerobic oxidation of butyrate to acetate and hydrogen by *Syntrophomonas* is illustrated by the following equation:

$$\text{Butyrate}^- \ + \ 2H_2O \ \text{------->} \ 2\,\text{acetate}^- \ + \ H^+ \ + 2H_2 \qquad \Delta G^{o'} = +48.2\text{kJ}$$

Although the reaction is highly unfavorable under standard conditions, the effective butyrate degradation can be still observed in actual methanogenic consortia.
   (a) Please briefly describe how to make the anaerobic oxidation of butyrate exergonic (3pts) and what kind of microbial interaction should occur. (3pts)
   (b) Please describe two possible coupling microbial processes (i.e., reactions and microorganisms) to facilitate the complete degradation of butyrate to methane. (8 pts)