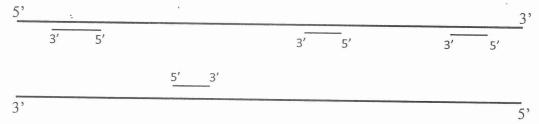
國立中央大學103學年度碩士班考試入學試題卷

所別:環境工程研究所碩士班 甲組(一般生) 科目:環境化學及環境微生物學 共 2 頁 第 1 頁 本科考試禁用計算器 *請在試卷答案卷(卡)內作答

Equations and constants that you may need are provided on Page 2.

- 1. Please define or explain the followings:
 - a. Anammox (4 points)
 - b. Bacteriostatic effects (4 points)
 - c. Horizontal gene transfer (4 points)
 - d. Biomineralization (4 points)
 - e. Point of zero charge (4 points)
 - f. The octanol-water partition coefficient (K_{ow}) (4 points)
 - g. The critical micelle concentration (4 points)
 - h. Indirect photolysis (4 points)
- 2. Molecular biology techniques have been regularly employed in the studies of environmental microbiology and proved to be powerful tools in probing the mechanisms that may underlie microbially mediated processes.
 - a. How would you identify a specific bacterium from a soil sample without prior cultivation using molecular techniques? (4 points)
 - b. If you would like to use PCR to assess microbial <u>activity</u>, what type of PCR would you use and why? **(4 points)**
 - c. At the beginning of PCR there are two template DNA strands (T). As amplification proceeds, short strands (S) and long strands (L) are generated. After 5 cycles of PCR, how many total strands each of T, S, and L are there? Show your calculations. (8 points)
 - d. The schematic below shows the position and orientation of four primers used in nested PCR. How many amplification products will be obtained? Explain your answer. (4 points)



- 3. Why do we look at fecal indicator bacteria (i.e., total coliform, *E. coli*, and *Enterococcus*) rather that at specific pathogens in routine water quality monitoring? (4 points)
- 4. Pure water has been brought into contact with excess $CaCO_{3(s)}$ (it will still be present at equilibrium). While $CaCO_{3(s)}$ dissolution takes place, the pH is fixed at 8.0 through the addition of either a strong acid (HCl) or a strong base (NaOH). The system is closed to the atmosphere.
 - a. Calculate $[Ca^{2+}]$ and $[C_T]$ (which is the sum of $H_2CO_{3(aq)}$, HCO_3^- and CO_3^{2-}) when saturation with respect to $CaCO_{3(s)}$ is attained? (15 points)
 - b. To keep the pH fixed at 8.0, was it necessary to add HCl or NaOH? How much? (5 points)

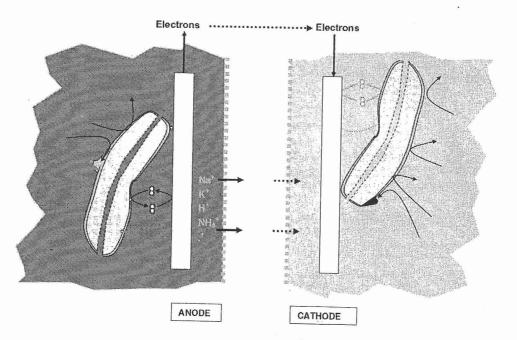


注:背面有試題

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- 5. If 10 mg of naphthalene is added to 1 liter of water in a 20-liter sealed bottle (the solubility of naphthalene is 2.6×10^{-4} mol/liter, and the vapor pressure is 3×10^{-4} atm at 20°C. What percentage of the total naphthalene ends up in the air-filled volume of the bottle at equilibrium? [Hint: it would be useful to find out the *dimensionless* Henry's law constant of naphthalene first] (14 points)
- 6. Below is a schematic representation of a microbial fuel cell system.
 - a. In order to make this system produce electricity, can aerobes (i.e., aerobic microbes) be cultured in the anode chamber? Explain your answer. (4 points)
 - b. It has been hypothesized that microbes may excrete redox-active molecules acting like electron shuttles and use such molecules to process extracellular respiration (so that microbes do not need to directly contact and respire insoluble terminal electron acceptors, such as the electrodes shown in this cartoon). Design a simple experiment to test this hypothesis using MnO_{2(s)} or Fe₂O_{3(s)}. (6 points)



(Rabaey et al., ISME 2007, modified)

Equations and Constants:

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 $CO_2 + H_2O \ \ H_2CO_3^*;$ $H_2CO_3^* \ \ HCO_3^- + H^+;$ $HCO_3^- \ \ CO_3^{2^-} + H^+;$ $CaCO_3 \ \ Ca^{2^+} + CO_3^{2^-};$ $K_H = 10^{-1.5} \text{ mol/(atm· liter)} = 3.16 \times 10^{-2} \text{ mol/(atm· liter)}$ $K_{a1} = 10^{-6.3} \text{ mol/liter} = 5 \times 10^{-7} \text{ mol/liter}$ $K_{a2} = 10^{-10.3} \text{ mol/liter} = 5 \times 10^{-11} \text{ mol/liter}$ $K_{sp} = 10^{-8.35} \text{ mol}^2/\text{liter}^2 = 4.47 \times 10^{-9} \text{ mol}^2/\text{liter}^2$



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