國立中央大學 107 學年度碩士班考試入學試題

所別： 環境工程研究所 碩士班 甲組(一般生)　　共 2 頁 第 1 頁

科目： 環境化學及環境微生物學

本科考試禁用計算器　　＊請在答案卷(卡)內作答

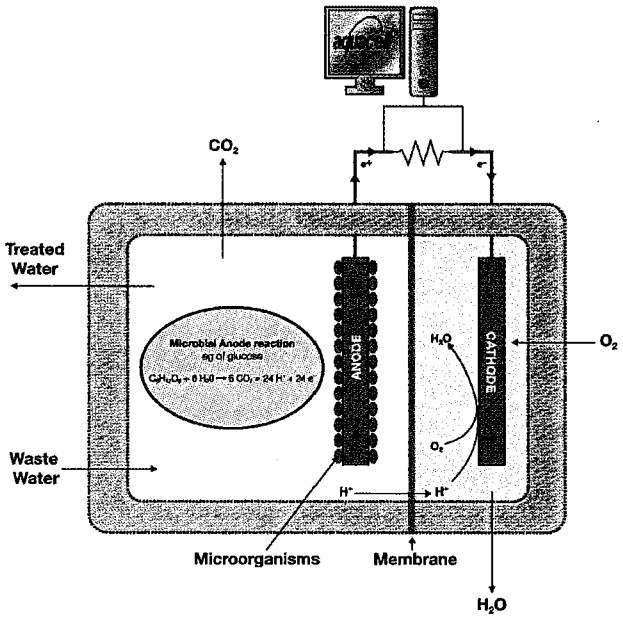
I. Consider the following reaction: **[15 points]**

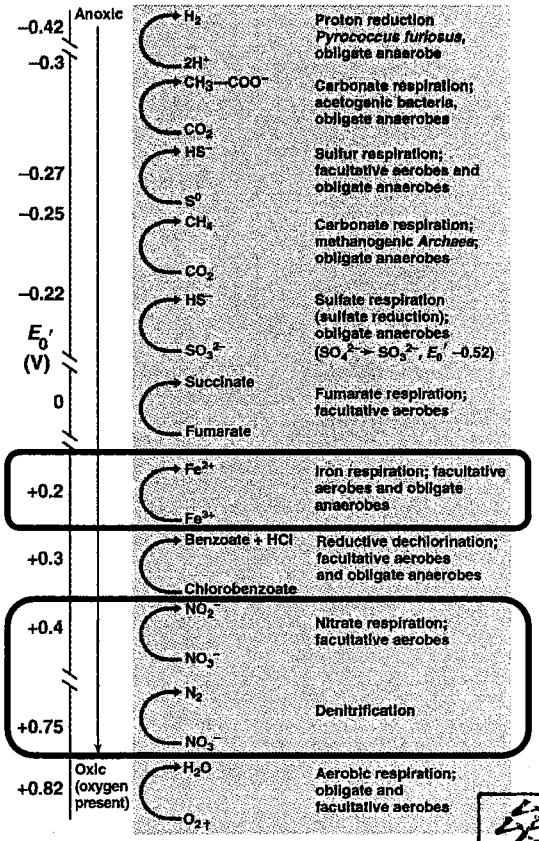
$$1/2\ H_2SeO_3 + 3H^+ + 3e^- = 1/2\ H_2Se + 3/2\ H_2O \qquad \log K = 18.3$$

If pe is defined as "–log [e^-]", what is the pe of the system if (H_2SeO_3) = (H_2Se)? Also, it is known that $E_h = 0.059$ pe, so what would you predict the ratio of H_2SeO_3 to H_2Se to be, if the E_h were -0.1 V? Assume the pH is 7.

II. A conventional microbial fuel cell (MFC) system consisting of an anode, a cathode, and a proton exchange membrane can be used to treat wastewater containing high BOD and produce electricity (see the cartoon below). The reason that this system can work is because cells in the anodic chamber are capable of "breathing" the anode extracellularly.

1. If the reduction potential of the anode is similar to ferric iron (i.e., Fe^{3+}), would you expect that this MFC system is able to "simultaneously" exhibit efficient nitrogen removal and electricity production when the wastewater contains elevated BOD and nitrate concentrations, according to the electron tower shown below. Explain your answer. **[10 points]**
2. In addition to removing BOD, if the wastewater contains high levels of sulfate and you would also like to remove it, how can you use this system to do it, when considering that the cells can both "breath" and "eat" electrode? Explain your answer. **[10 points]**





注意:背面有試題

參考用

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III. Using the hydrolysis reactions for aluminum and ferric given below, draw two "logC-pH" diagrams: one for the hydrolysis of ferric ion, and the other for aluminum ion. On each diagram, include the lines for all the hydrolysis species identified, and identify the zone of $Al(OH)_{3(s)}$ and $Fe(OH)_{3(s)}$ precipitation. Based on your diagrams, what strikes you as the main difference between them? What does that mean in terms of the expected performance of ferric and alum for water treatment as a function of water pH? **[50 points]**

	pKa (25°C)
$Al^{3+} + H_2O = Al(OH)^{2+} + H^+$	4.97
$Al(OH)^{2+} + H_2O = Al(OH)_2^+ + H^+$	4.3
$Al(OH)_2^+ + H_2O = Al(OH)_3 + H^+$	5.7
$Al(OH)_3 + H_2O = Al(OH)_4^- + H^+$	8.0
$2Al^{3+} + 2H_2O = Al_2(OH)_2^{4+} + 2H^+$	7.7
$3Al^{3+} + 4H_2O = Al_3(OH)_4^{5+} + 4H^+$	13.9
$13Al^{3+} + 28H_2O = Al_{13}O_4(OH)_{24}^{7+} + 32H^+$	98.7
$Al^{3+} + 3OH^- = Al(OH)_{3(s)}$	31.5

	pKa (25°C)
$Fe^{3+} + H_2O = Fe(OH)^{2+} + H^+$	2.2
$Fe(OH)^{2+} + H_2O = Fe(OH)_2^+ + H^+$	3.5
$Fe(OH)_2^+ + H_2O = Fe(OH)_3 + H^+$	6.0
$Fe(OH)_3 + H_2O = Fe(OH)_4^- + H^+$	10
$2Fe^{3+} + 2H_2O = Fe_2(OH)_2^{4+} + 2H^+$	2.9
$3Fe^{3+} + 4H_2O = Fe_3(OH)_4^{5+} + 4H^+$	6.3
$Fe^{3+} + 3OH^- = Fe(OH)_{3(s)}$	38.7

IV. Choose your answers. **[15 points]**

1. A reaction under experimental conditions will go forward as written if:
   a. $\Delta G° < 0$
   b. $\Delta G < 0$
   c. $\Delta G° > 0$
   d. $\Delta G > 0$
   e. Only if both ΔG and $\Delta G°$ are negative
   f. Only if both ΔG and $\Delta G°$ are positive
2. If a substance is in its reduced form, it could possibly be used as an electron acceptor for certain types of bacteria.
   a. True
   b. False
3. The time between inoculation and the beginning of growth is usually called the
   a. Lag phase.
   b. Log phase.
   c. Dormant phase.
   d. Death phase.
4. In an electron carrier system, the net energy change is determined by the difference in reduction potentials between the
   a. Primary electron donor and the terminal electron donor.
   b. Primary electron acceptor and the terminal electron acceptor.
   c. Primary electron acceptor and the terminal electron donor.
   d. Primary electron donor and the terminal electron acceptor.
5. Which of the following are made up of **prokaryotic cells**?
   a. Bacteria and fungi
   b. Archaea and fungi
   c. Protozoa and animals
   d. Bacteria and archaea

參考用

注意:背面有試題