

The Open University of Sri Lanka

B.Sc. Degree Programme 2011/2012

CMU 3129 - Environmental Chemistry



FINAL EXAMINATION

Two (02) hours

Date: 24.11.2012

Time: 9.30 am – 11.30 am.

ANSWER ANY FOUR (04) QUESTIONS

- 1.a. i. Define the term 'residence time' as applied to environmental chemistry.
- ii. Calculate the residence time of  $HCO_3^-$  in sea water, given that the input of  $HCO_3^-$  to Oceans from river is  $2 \times 10^{12}$  kg/yr. The amount of  $HCO_3^-$  in oceans is  $2 \times 10^{17}$  kg. Write any assumption(s) that you make.

(20 marks)

- b. Indicating the characteristics of the regions, draw the temperature profile of the atmosphere up to an altitude of 50 km. Explain the variation of temperature within.

(40 marks)

- c. Briefly describe the atmospheric sources, sinks and environmental effects of CO and  $CH_4$ .

(40 marks)

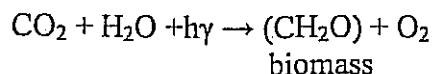
2. a. i. Draw the carbon cycle.
- ii. How will the following anthropogenic activities affect the carbon cycle?

(α) Fossil fuel combustion

(β) Mining of coral for building industry

(40 marks)

- b. In photosynthesis, Inorganic carbon is converted to biomass according to the following equation.



If the total inorganic carbon concentration ( $\text{mol dm}^{-3}$ ) at pH = 7 and pH = 10 are given as  $1.22 \times 10^{-3}$  and  $6.82 \times 10^{-4}$  respectively, calculate the increase of biomass at high pH. Express your answer in  $\text{mg dm}^{-3}$ .

[C =12; H=1; O=16]

(30 marks)

- c. i. What is meant by 'thermal stratification' of a lake.

- ii. Draw a labelled diagram to illustrate stratification of a lake in a temperate climate, showing the typical forms of the main elements in it.

(30 marks)

3. a. i. What do you mean by acid rain.  
 ii. Write the sources and sinks of  $\text{SO}_2$  and  $\text{NO}_x$   
 iii. Briefly describe the effects of acid rain on water bodies and materials.  
 iv. An accidental leakage of  $\text{SO}_2$  from a sulphuric acid manufacturing plant situated in an area caused the partial pressure of  $\text{SO}_2$  in the atmosphere to increase to 0.1 Pa.

For  $\text{SO}_2$ ,  $K_H = 1.25 \times 10^{-5} \text{ mol dm}^{-3} \text{ Pa}^{-1}$ .

$K_a$ , for  $\text{H}_2\text{SO}_3(\text{aq}) \leftrightarrow \text{H}^+(\text{aq}) + \text{HSO}_3^-(\text{aq})$   $1.7 \times 10^{-2} \text{ mol dm}^{-3}$

Calculate the pH of rain water falling into the area.

Assume no contribution from other acidic gases present, the dissociation of  $\text{HSO}_3^-$  is negligible and also no further oxidation of  $\text{SO}_2$  is taking place by air.

(70 marks)

- b. i. Define the term 'Alkalinity'  
 ii. Titration of 100.0 ml of river water with 0.100 M HCl solution consumes 2.85 ml HCl to the methyl orange equivalence point. Calculate the total alkalinity in
- equivalent of acid per litre ( $\text{eq L}^{-1}$ )
  - $\text{mg L}^{-1} \text{ CaCO}_3$

(30 marks)

4. a. i. Draw the variation of concentration of stratospheric ozone.  
 ii. Briefly describe the environmental effects of the use of chlorofluorocarbons in industrial applications.

(25 marks)

- b. i. Briefly explain the phenomenon, 'global warming'  
 ii. Identifying the major cause(s) of global warming, briefly describe its consequences.

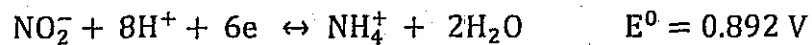
(25 marks)

- c. i. Write one example of each of linear and ring poly phosphates.  
 ii. Give two uses of polyphosphates in industry.  
 iii. Show by chemical equation the ultimate product of polyphosphate hydrolysis.

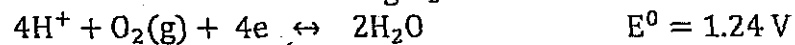
- iv. Briefly describe the environmental consequence resulting from the presence of significant amount of phosphate in water. (20 marks)
- d. i. What do you mean by the term 'coagulation' in water treatment process?  
 ii. Give two examples for chemical coagulants.  
 iii. What are their functions? (30 marks)
5. a. i. Write the conditions necessary for the formation of photochemical smog.  
 ii. Draw and explain the diurnal variation of concentration of components of photochemical smog on a smoggy day.  
 iii. Write equations to show the formation of ozone and PAN. (60 marks)
- b. i. Define the terms BOD and COD.  
 ii. What is the BOD of water in which 10 mg of sugar (empirical formula  $\text{CH}_2\text{O}$ ) is dissolved in a litre?  
 iii. Why do the COD analysis and  $\text{BOD}_5$  analysis usually give different results for the same wastewater? (40 mark)
6. a. i. Give the unique properties of water and their significance in biosphere.  
 ii. Lakes are generally classified into three types. What are they? What are their characteristics? (30 marks)
- b. i. Write down the mathematical expression for the Henry's Law and identify the terms in it.  
 ii. Calculate the pH of a solution of ammonia in equilibrium with  $\text{NH}_3$  gas having a partial pressure of  $5.06 \times 10^3 \text{ Pa}$  at  $25^\circ\text{C}$ . For  $\text{NH}_3$ , Henry's law constant,  $K_H$  is  $5.7 \times 10^{-4} \text{ mol dm}^{-3} \text{ Pa}^{-1}$ ;  
 $K_b$  for  $\text{NH}_3 + \text{H}_2\text{O} \leftrightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-$  is  $1.8 \times 10^{-5} \text{ mol dm}^{-3}$ . (30 marks)
- c. i. Define the term pE.  
 ii. What is the use of a pE – pH diagram?

- iii. How does pE vary with depth in a stratified lake? Explain.
- iv. Calculate the equilibrium partial pressure of oxygen ( $P_{O_2}$ ) in a water sample containing equal concentrations of nitrite,  $NO_2^-$  and ammonium ion,  $NH_4^+$  at pH = 7.

For the half reaction of nitrite to ammonia



For the half reaction involving  $O_2$  reduction



(40 marks)