

THE OPEN UNIVERSITY OF SRI LANKA

B.Sc. DEGREE PROGRAMME IN SCIENCE

ENVIRONMENTAL CHEMISTRY – CMU3129/CME 5129

FINAL EXAMINATION – 2014/15

Duration: 2 HOURS.



Date: 05.05.2015

Time: 9.30 a.m. – 11.30 a.m.

ANSWER ANY FOUR (04) QUESTIONS.

If more than four questions are answered only first four answers will be marked.

- 1.a.
 - i. Define the term 'residence time'.
 - ii. The mass of nitrogen in the atmosphere is 4×10^{18} kg, and its sinks from the atmosphere include (i) biological nitrogen fixation by bacteria, 2×10^{11} kg yr⁻¹; (ii) production of NO in thunderstorms, 7×10^{10} kg yr⁻¹; (iii) chemical synthesis of ammonia, 5×10^{10} kg yr⁻¹. Calculate the residence time of nitrogen in the atmosphere. **(20 marks)**
- b.
 - i. Define the terms, 'source' and 'sink' as used in environmental chemistry. Write equation(s) to show the source(s) and sink(s) of stratospheric ozone.
 - ii. Indicating altitudes and temperatures draw and explain the temperature profile in the stratospheric region of the atmosphere. Sketch the variation of concentration of ozone in this region. **(45 marks)**
- c.
 - i. Giving one example in each case, distinguish between a primary pollutant and a secondary pollutant.
 - ii. Write the conditions necessary for the formation of Los Angeles- type smog.
 - iii. Identifying the chemical constituents of Los Angeles smog, briefly describe their environmental effects. **(35 marks)**
- 2.a.
 - i. What is meant by 'acid rain'?
 - ii. Identifying the sources of acid rain, briefly describe the formation of acid rain from them. **(30 marks)**

b. i. Briefly describe the phenomenon that heats up the troposphere. Draw and explain the variation of temperature in the troposphere.

ii. What do you mean by 'global warming? Briefly describe the consequences of global warming. (50 marks)

c. i. What is meant by the term 'eutrophication'?

ii. Write the most important elements that contribute to eutrophication.

iii. Give **three** adverse effects of eutrophication in an aquatic system.

iv. Briefly explain how it can be controlled.

(20 marks)

3.a. i. State the Henry's Law.

ii. Give the mathematical expression for the Henry's Law and identify the terms in it.

iii. An unopened soda can has an aqueous CO₂ of 0.0506 M at 25° C. What is the pressure of CO₂ gas in the can?

Henry's Constant, K_H for CO₂ at 25° C is $3.3 \times 10^{-7} \text{ mol L}^{-1} \text{ Pa}^{-1}$

(30 marks)

b. i. Briefly explain the environmental hazards that may arise from the following anthropogenic chelating agents.

- Sodiumtripolyphosphate (STP)
- Nitrilotriacetic acid (NTA)
- Ethylenediaminetetraacetic acid (EDTA)

(30 marks)

c. Write **three** unique properties of water and their significant effect upon the life on the Earth. (20 marks)

d. i. What do you mean by Threshold Limit Values (TLV) of indoor air pollutants?

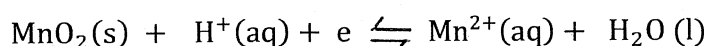
ii. Comment on the TLV (mg m⁻³) of toluene (375) and benzene (30).

(20 marks)

4. a. i. What do you understand by the term 'alkalinity' of a water sample?
- ii. A water sample has a pH of 8 and a measured total alkalinity of 140 mg CaCO_3/L . Determine the molar concentrations of the species which contributed to this alkalinity. The second dissociation constant of H_2CO_3 , $K_{a2} = 4.69 \times 10^{-11} \text{ mol/L}$
- (30 marks)**

- b. i. Define pE.
- ii. What is the range of pE in natural water?
- iii. A sample from a lake gave a $\text{pE} = 10.5$. Do the condition in this lake oxidation?

Consider the following redox reaction in a natural aquatic system.



- iv. Write a balanced equation for the above redox reaction in terms of one electron-mole.
- v. Given that for this reaction E° is 1.25 V, calculate pE° for the redox equilibrium.
- vi. Derive a relationship between pE and pE° , $[\text{Mn}^{2+}]_{\text{aq}}$, pH for the above redox reaction.
- vii. If $[\text{Mn}^{2+}]_{\text{aq}} = 10^{-5} \text{ mol L}^{-1}$, calculate pE of the redox reaction at $\text{pH} = 8$.

(50 marks)

- c. i. What are polychlorinated biphenyls (PCBs)?
- ii. Give **three** uses of PCBs.
- iii. Describe the effects of PCBs when they enter the environment.

(20 marks)

- 5.a i. Define the term 'Chemical Oxygen Demand (COD)' of a wastewater sample.
- ii. Distinguish between Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).
- iii. The COD of a water sample is 25 mg of O_2 / L . What volume of 0.0010 mol /L $\text{Na}_2\text{Cr}_2\text{O}_7$ solution is required to titrate a 40 ml of this water sample?

[Hint: the dichromate ion oxidizes 1.5 times the material that molecular O_2 does].

(30 marks)

- b. i. The primary wastewater treatment involves several stages. These stages include skimming, sedimentation, flocculation, chemical coagulation, neutralization. Describe what happens at each of these stages. **(20 marks)**
- c. i. What is meant by the term 'disinfection' of water in a water treatment process?
- ii. Cl_2 gas is used for disinfection of drinking water. Explain its action during disinfection.
- iii. What are "combined available chlorines"? How are they formed? Give its significant. **(20 marks)**
- d. i. What do you understand by the term 'incineration' of solid wastes?
- ii. Give **three** advantages of incineration of solid wastes.
- iv. Discuss the **two** major environmental issues directly related to incinerator. **(30 marks)**
- 6.a. i. What is humus?
- ii. Why soil organic matter is an important component for plant growth?
- iii. What do you understand by 'peat soil'? **(20 marks)**
- b. i. What is buffering capacity of soil?
- ii. Discuss briefly how it is changed with the composition of soil **(30 marks)**
- c. i. What is meant by acidification of soil?
- ii. What are the anthropogenic activities that cause soils to be acidic?
- iii. What is the major consequence of soil acidity? **(20 marks)**
- d. i. Briefly describe the structure of clay minerals.
- ii. What type of clay minerals may have high cation exchange capacity? Explain. **(30 marks)**