

The Open University of Sri Lanka

B.Sc Degree Programme / Stand Alone Courses in Science

Environmental Chemistry – CMU3129/CME5129

Final Examination 2012/13

Duration: Two hours



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Date: 07.12.2013 (Saturday)

Time: 9.30 a.m. – 11.30 a.m.

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ANSWER ANY **FOUR (04)** QUESTIONS.

IF MORE THAN FOUR QUESTIONS ARE ANSWERED, **ONLY THE FIRST FOUR ANSWERS WILL BE MARKED.**

1. The atmosphere and its constituents perform important functions to sustain life on the planet Earth. However, over the years, it has been at the receiving end for most of the pollutants produced by humans. Some of these have far reaching consequences affecting climate and weather patterns while the others have affected public health.
  - i. Write the **three** major constituents in the atmosphere.
  - ii. What makes the gases referred to in (i) major constituents is that it has long mean 'residence time'. Define the term residence time.
  - iii. Briefly describe **four** important functions of the atmosphere.
  - iv. Identifying the main contributors, briefly describe the principal phenomena that warm the troposphere and stratosphere.
  - v. Sketch the temperature profile of the atmosphere up to 50 km. Locate the thermal inversions in the diagram.

(100 marks)

- 2.a. Ozone performs a beneficial function in the stratosphere while it is a secondary pollutant in the photochemical smog in the troposphere. Stratospheric ozone and its fate has been the subject of debate for many years and finally paved the way for the signing of the Montreal protocol.
  - i. Define the terms, 'source' and 'sink' as used in environmental chemistry.
  - ii. Write down the mechanism by which O<sub>3</sub> is formed in the stratosphere. Briefly describe the beneficial role played by ozone in the stratosphere.

- iii. Break down of ozone in the stratosphere is catalyzed by NO, OH and other radicals. Write down the mechanism for the destruction of ozone by NO.
- iv. Distinguish between primary pollutant vs. secondary pollutant.
- v. Write the conditions necessary for the formation of photochemical smog and identify the components in it.

(70 marks)

b. Water plays an important role in sustaining aquatic life.

- i. Write down **three** physical properties of water and their significance in aquatic life.
- ii. What is meant by the term “productivity “of a water body and briefly explain how it is related to water quality. (30 marks)

3.a. Increased levels of greenhouse gases (GHG) have given rise to ‘global warming’. Methane, CO<sub>2</sub> and chlorofluorocarbons are well known GHGs.

- i. Write the source(s) and sink(s) of methane.
- ii. What do you mean by ‘global warming’?
- iii. Briefly describe **three** consequences of global warming.

(40 marks)

- b. i. What do you understand by the term “thermal stratification”?
- ii. Draw a labeled diagram to show stratification of a lake in the summer and indicate the typical forms of the main elements in it.
- iii. Explain how does dissolved oxygen vary with the depth of this lake.

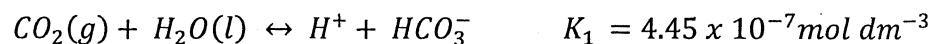
(40 marks)

- c. i. What are PCB’s?
- ii. Write down their properties, sources and uses.

(20 marks)

- 4.a. i. Define the term alkalinity of a water body.
- ii. Why alkalinity is important for a water body?
- iii. What are the main sources of alkalinity in water?

- iv. The water with an alkalinity of  $2.00 \times 10^{-3}$  equivalent /liter has a pH of 7.00. The equilibrium constants for the following reactions are



Hint: At pH 7.0, the dominant species is  $\text{HCO}_3^-$ . Concentration of  $\text{CO}_3^{2-}$  is negligible.

Calculate  $[\text{CO}_2]$ ,  $[\text{HCO}_3^-]$ ,  $[\text{CO}_3^{2-}]$  and  $[\text{OH}^-]$ .

(50 marks)

- b. i. Write down the mathematical form of Henry's Law and identify the terms in it.
- ii. Calculate the pH of  $\text{CO}_2$  – saturated water at  $25^\circ\text{C}$ , given that the  $\text{CO}_2$  concentration in air is  $3.5 \times 10^{-4}$  atmosphere, and that for  $\text{CO}_2$  the Henry's constant  $K_H = 3.4 \times 10^{-2} \text{ mol L}^{-1} \text{ atm}^{-1}$  at  $25^\circ\text{C}$ ; the ionization constant  $K_a$ , for  $\text{H}_2\text{CO}_3$  has a value of  $4.5 \times 10^{-7} \text{ mol L}^{-1}$  at this temperature.

(30 marks)

- c. i. Briefly explain what is composting?
- ii. What are the environmental issues related to composting?

(20 marks)

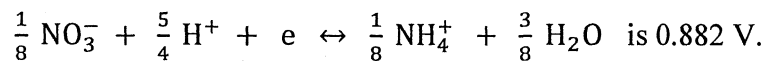
- 5.a. i. Define the terms Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).
- ii. Explain why their values for the same water samples can differ?
- iii. A polluted water sample is suspected of being contaminated with ABS (Alkyl Benzene sulphonate) or LAS (Linear Alkyl Sulphonate). The sample has a very low BOD relative to its COD. Which is the contaminant? Explain your answer.
- iv. Calculate the COD of industrial wastewater samples containing  $400 \text{ mg L}^{-1}$  of stearic acid,  $\text{C}_{18}\text{H}_{36}\text{O}_2$  [Atomic weight: C=12; H=1; and O=16].

(40 marks)

- b. i. Give the mathematical expression for pE.
- ii. What are the uses of a pE –pH diagram?

- iii. What does a negative pE value imply about the solution?
- iv. Calculate the equilibrium ratio of  $\text{NH}_4^+$  to  $\text{NO}_3^-$  at pH = 6 in an aerobic water having a pE value of = +11.

Given that  $E^\circ$  value for



(40 marks)

- c. Soil pH is an important property that influences much chemical and biological procedure occurring in soil. Acidification can occur due to acid rain. Explain by giving **two** examples how acid rain affects soil?

(20 marks)

6. a. i. What are soil forming rocks?

- iii. Name **three** soil forming factors and briefly explain how they affect soil formation.

(30 marks)

- b. i. Classify the soil in terms of soil texture.

- ii. Discuss the properties of sandy soil, clay soil and loam soil.

- iii. Explain how loamy soil facilitates growth of plants.

(25 marks)

- c. i. Define the term “cation exchange capacity (CEC) of soil.

- ii. Identify **two** important aspects of CEC in soil.

(15 marks)

- d. i. What do you understand by disinfection of water?

- ii. Briefly explain how chlorine destroys water born pathogen.

- iii. What is meant by “combined available chlorines” and how do they form?

- iv. What is the role of combined available chlorine in disinfection of water?

(30 marks)