The Open University of Sri Lanka

B.Sc. Degree Programme / Continuing Education Programme

Environmental Chemistry- CMU3129/CME5129

Final Examination- 2016/17

Duration: 2 hours

| Date: 23.07.2017 | 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 first four answers will be marked.

1.a. Atmosphere is a thin layer of gases surrounding the Earth which protects and supports life. Major constituents have long residence time. Minor constituents such as $CO_2$ maintains Earth's heat balance while ozone protects life from harmful UV radiation.

    i.      Write down the major constituents in the Earth's atmosphere.

    ii.     Defining the term 'residence time', calculate the residence time of a pollutant X in the atmosphere, if X is removed from the atmosphere by deposition (0.2 % per day) and by chemical transformation (1.2 % per day).

    iii.    Draw and explain the temperature profile of the atmosphere up to 50 km.

    iv.    Explaining what is meant by 'global warming'; briefly describe **three** consequences of global warming.
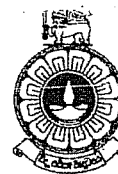
(75 marks)

b.    Acid rain' became a household term in the 1980s when unchecked emissions from industry and motor vehicles were blamed for causing environmental degradation. Scientific evidence has linked acid rain to decreased fish and wildlife populations, degraded lakes and streams, and human health hazards. Although the term has since faded from public consciousness, acid rain is a complex and global problem that still exists today.

    i.      What do you mean by 'acid rain'?

    ii.     Briefly describe the formation of acid rain.

(25 marks)

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2. a. Ozone ($O_3$) is formed in the stratosphere by photolysis of $O_2$ and is important for our protection from harmful UV radiation. Ozone is harmful for humans and vegetation, and an air quality standard is needed. At present surface air concentration of $O_3$ may not exceed 0.10 ppm in Sri Lanka.

      i.      Defining the terms, 'source' and 'sink' as used in environmental chemistry, write equations to show the source(s) and sink(s) of stratospheric ozone.

      ii.     Draw the typical variation of concentration of ozone vs. altitude in the stratosphere.

      iii.    Briefly describe the appearance of 'polar ozone holes' over Antarctica.

Ozone is formed as a secondary pollutant in the troposphere as one of the constituents of photochemical smog which is an adverse form of air pollution in major cities causing health hazards.

      iv.    Distinguish between a primary pollutant and a secondary pollutant.

      v.     Write the conditions necessary for the formation of photochemical smog.

      vi.    Briefly write the health effects of ozone.

**(80 marks)**

  b.   i.   Draw the Nitrogen cycle.

      ii.     Give an example of how the nitrogen cycle balance has been disturbed through anthropogenic activities.

**(20 marks)**

3. a.   i.   The anomalous density of water is quite important for aquatic environment. Explain this.

      ii.   Describe thermal stratification of a lake with a help of a diagram.

      iii.  How does stratification affect water quality?

**(30 marks)**

  b.    i.   Name **three** factors that affect dissolved $O_2$ levels in water bodies. Do these factors increase or decrease the amount of $O_2$ available to fish?

      ii.   State Henry's Law. What are the key assumptions or conditions for Henry's Law?

iii. The solubility of $CO_2$ in water is 0.161 g/100 ml at 20° C and at partial pressure of 1 atmosphere. What partial pressure of $CO_2$ is necessary in a soft drink canning process in order to allow the solubility of $CO_2$ is equal to 0.886 g/100 mL?

[Relative atomic mass; C=12; O = 16]

**(40 marks)**

c. i. What do you understand by the term "Total alkalinity"?

ii. A water sample obtained from an area of dolomite limestone has pH 7.0 and total alkalinity $2.3 \times 10^{-3}$ mol of $H^+$/L. Calculate the concentrations of $[CO_2]aq$, $[HCO_3^-]$, $[CO_3^{2-}]$ and $[OH^-]$ in the water.

Given that $K_{a1}$ ($H_2CO_3$) = $4.2 \times 10^{-7}$ mol/L and $K_{a2}$ ($HCO_3^-$) = $4.8 \times 10^{-11}$ mol/L

**(30 marks)**

4. a. i. Define and distinguish the biochemical oxygen demand (BOD) and chemical oxygen demand (COD).

ii. A raw sewage sample has organic matter content of 720 mg/L. Assume that the only organic matter presents in it was glucose, $C_6H_{12}O_6$. What is the $O_2$ requirement for the complete oxidation of $1.2 \times 10^5$ L of this sewage. Give your answer in mg of $O_2$. [Relative atomic mass: C = 12; H = 1; O = 16]

**(30 marks)**

b. i. Explain the phenomena of acid mine drainage, by writing appropriate balanced chemical equations.

ii. A water sample from an acid mine site has found to be contained $[Fe^{3+}]$ = $8.0 \times 10^{-3}$ mol/L and $[Fe^{2+}]$ = $4.0 \times 10^{-4}$ mol/L. Assume that this system is at equilibrium, estimate the pE for this water.

Given that, $Fe^{2+} \rightleftharpoons Fe^{3+} + e^-$ $\qquad P^{E^o} = -13.2$

iii. What are the aquatic environmental problems associated with acid mine drainage?

**(40 marks)**

c. i. Distinguish between temporary hardness and permanent hardness.

ii. The hardness of a water sample is determined by titrating 100.0 mL of sample against 0.01 mol /L EDTA solution. The Eriochrome Black T end point occurs at 11.20 mL EDTA solution. Calculate the hardness of the water sample in mg of $CaCO_3$ /L.

iii. Explain the lime soda process for the removal of permanent hardness in water.

**(30 marks)**

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5.a. i. What are the uses of arsenic that result in contamination of the environment?

ii. Discuss the biochemical effects of arsenic.

**(20 marks)**

b. i. List down the major classes of synthetic pesticides

ii. Discuss the health hazardous arising from synthetic pesticides.

**(40 marks)**

c. i. What do you mean by "eutrophication of water body?

ii. Discuss the effects of eutrophication.

iii. Discuss the probable ways to mitigate the problem.

**(20 marks)**

d. Discuss the environmental hazardous that may arise from the detergents.

**(20 marks)**

6. a. i. What is meant by incineration of waste?

ii. Name **three** types of incineration that are used to destroy wastes.

iii. Discuss the two major environmental issues directly related to incineration.

**(30 marks)**

b. i. Explain the chemistry underlying the disinfection of water by chlorine.

ii. What is combined available chlorine? Show by equation how it is formed?

iii. Write three methods, other than chlorination, are used to disinfect water.

**(30 marks)**

c. i. Briefly discuss the effect of climate and topography on properties of soil.

ii. How do soil minerals develop positive and negative charge?

iii. List down **three** major processes that can control the entry of ions and molecules into the soil solution.

**(40 marks)**

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