



The Open University of Sri Lanka  
Faculty of Natural Sciences  
B.Sc. / B. Ed. Degree Programme

Department	: Chemistry
Level	: 5
Name of the Examination	: Final Examination
Course Code and Title	: <b>CYU5309/CMU3129 Environmental Chemistry</b>
Academic Year	: 2019/20
Date	: 27 <sup>th</sup> December 2019
Time	: 9.30 a.m. – 11.30 a.m.
Duration	: Two hours

### General Instructions

Read all instructions carefully before answering the questions.

2. This question paper consists of six **(06)** questions in four **(05)** pages.
  3. Answer any four **(04)** questions only. All questions carry equal marks.
  4. Answer for each question should commence from a new page.
  5. Draw fully labelled diagrams where necessary
  5. Relevant log tables are provided where necessary.
  6. Having any unauthorized documents/ mobile phones in your possession is a punishable offense
  7. Use blue or black ink to answer the questions.
  8. Circle the number of the questions you answered in the front cover of your Answer script.
  9. Clearly state your index number in your answer script
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1.a Our atmosphere is an extraordinary mixture of gases and suspended particles with varying residence times. Major gases such as  $N_2$  and  $O_2$  have long residence times while minor constituents such as  $CO_2$  maintain troposphere's heat balance while stratospheric ozone protects life on Earth from radiation.

- i. Defining the term, 'residence time', calculate the residence time of water in the ocean, given that the total volume of water on Earth is  $1.4 \times 10^9 \text{ km}^3$  and the river influx is  $3.7 \times 10^4 \text{ km}^3/\text{yr}$ .
- ii. Draw the nitrogen cycle and give **one** example of an anthropogenic activity that disturbs this cycle.
- iii. Defining the term, 'source', write down the Chapman mechanism for stratospheric ozone.
- iv. Draw the typical vertical profile of ozone in the stratosphere.
- v. Defining the term, 'sink', write down **two** sinks of carbon dioxide.

(75 marks)

- b. Global Warming Potential (GWP) of methane is about 20 times more than that of carbon dioxide. Defining the term 'Global Warming Potential', briefly describe **two** consequences of global warming.

(25 marks)

2.a. The atmosphere is loaded with emissions from vehicles, industries and power plants. Besides carbon dioxides, there are many gases emitted leading to environmental catastrophes such as smogs and acid rain.

- i. Identifying the source(s) for each, list the pollutant(s) responsible for sulphurous and photochemical smogs and acid rain.
- ii. Explaining what is meant by the term, 'acid rain', briefly describe **two** adverse effects of it on water bodies.
- iii. What are the necessary conditions for photochemical smog? Write down the components of photochemical smog.
- iv. Defining the terms, 'primary pollutant' and 'secondary pollutant', identify the primary pollutants and secondary pollutants from the lists given in (i).

(80 marks)

- b. Chelating agents in aquatic systems are of primary concern as it pollutes water.

- i. List down chelating agents that are released into the aquatic system
- ii. Briefly discuss the environmental significance of the anthropogenic chelating agents.

(20 marks)

3.a. Unique properties of water have great environmental significance.

i. How do the unique properties of water contribute to Earth's suitability as an environment of life?

The main threat to surface water quality is eutrophication.

ii. What are the nutrients referred to above?

iii. Describe the process occurring in the water leading to eutrophication.

iv. At what stage of sewage treatment are these nutrients removed?

(35 marks)

b.i. Briefly describe what is meant by Alkalinity of a water sample?

ii. Water sample has a pH of 8.0 and measured total alkalinity of 140 mg/L  $\text{CaCO}_3$ . Determine the molar concentration of the **three (03)** contributing species. Given that the second dissociation constant of  $\text{H}_2\text{CO}_3$ ,  $K_{a2} = 4.69 \times 10^{-11}$  mol/L.

(20 marks)

c. i. Define the term 'Biochemical Oxygen Demand' (BOD).

A sample of Brewery effluent was diluted from 50 cm<sup>3</sup> to 5 L with well aerated pure water. The diluted sample was divided into two halves. The dissolved oxygen concentration of one sample was measured immediately and the other half was stored under suitable conditions to determine the dissolved oxygen concentration. Concentration of dissolved oxygen of 9.8 ppm and 4.7 ppm respectively were recorded.

ii. What are the suitable conditions for storing sample?

iii. How long you have to store the sample for the BOD determination?

iv. Calculate the BOD of the brewery effluent.

(25 marks)

d. Indoor air quality is the air quality within and around buildings and structures and is known to affect the health, comfort and well-being of the occupants. The Threshold Limit Values (TLVs) for chemical substances are designed as guidelines to have a control on health hazards due to them.

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

ii. Comment on the TLV ( $\text{mg m}^{-3}$ ) of toluene (375) and benzene (30).

(20 marks)

- 4.a.i. What is meant by the terms total hardness, permanent hardness and temporary hardness?
- ii. 50.0 mL of a sample water consumed 15.0 mL of 0.01 M ethylenediaminetetraacetic acid (EDTA) before boiling and 5.0 mL of the same EDTA after boiling. Calculate the total of hardness, permanent hardness and Temporary hardness.
- iii. Supply of hard water is treated for domestic use by ion exchange. You may assume that all the hardness is due to  $Ca(HCO_3)_2$ . Explain in words or using a balanced equation how a cation exchange resin represented by  $RNa$  softens this water supply.
- iv. Why  $RNa$ , ion- exchange water softener is not the best choice for some people?  
**(40 marks)**
- b.i. State the Henry's Law. What are the key assumptions or conditions for Henry's Law?
- ii. At 20 °C the concentration of dissolved oxygen in water exposed to gaseous oxygen at a partial pressure of 101.3 kPa is  $1.38 \times 10^{-3}$  mol/L. Determine the solubility of oxygen when its partial pressure is 20.7 kPa.  
**(20 marks)**
- c. Explain the principles of secondary wastewater treatments.  
**(25 marks)**
- d.i. Define the solid wastes
- ii. What is meant by incineration of solid waste?
- iii. Discuss the two major environmental issues directly related to incinerator  
**(15 marks)**
- 5.a.i. How would you expect pE to vary with depth in a stratified lake?
- ii. A water sample from an acid mine was analyzed. It has a measured pH 2.00 and contained equal concentration of  $Fe^{2+}$  and  $Fe^{3+}$ . Calculate the partial pressure of oxygen. You are given that  $E^\circ$  for  $O_2/H_2O$  is +1.229 V and  $Fe^{3+}/Fe^{2+}$  is +0.771 V.
- iii. What are the aquatic environmental problems associated with acid mine drainage?  
**(30 marks)**
- b. Drinking water must be clean. It must meet the relevant water quality standard and must not contain microorganisms in concentrations or number that constitute danger to human health.

- i. Describe how suspended solids are removed in water treatment.
- ii. Describe the treatment that is carried out to ensure levels of microorganisms in drinking water.
- (20 marks)
- c. Explain how soil pollution could be prevented?
- (30 marks)
- d.i. Organophosphate and organochlorine are synthetic pesticides. Explain why organophosphates are better pesticides than organochlorine pesticides.
- ii. Discuss the effect of radiation on human health.
- (20 marks)
- 6.a.i. What is loam?
- ii. Why is it considered to be the best top soil for growing plants?
- (10 marks)
- b. Consider the following soils  
**Soil 1** is rich with Kaolinite and  
**Soil 2** is rich with Vermiculate.
- i. Briefly describe the building blocks of the mineral structure of soil 1 and 2 (diagram is not necessary)
- ii. What forces link the layers within the minerals for each soil?
- iii. Describe the swellings properties of each soil as a rain events occurs after a prolonged dry period.
- iv. Explain why the mineral Kaolinite might have a cation exchange capacity value of 10 m.eq. /100 g / sample whereas Vermiculate could equal to 140.
- (40 marks)
- c.i. The major Organic fraction of a soil is humus. It can be divided into **three** groups of substances. What are they?
- ii. Why organic matter is considered as an important soil component?
- (20 marks)
- d. Name and briefly describe the **five (05)** major factors influencing soil formation.
- (30 marks)

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