

The Open University of Sri Lanka
 Faculty of Natural Sciences
 Department of Chemistry



Level	: 5
Name of the Examination	: Final Examination
Course Code and Title	: CYU5309- Environmental Chemistry
Academic Year	: 2025/26
Date	: 10.01.2026
Time	: 1.30 p.m. – 3.30 p.m.
Duration	: 02 Hours

1. Read all instructions carefully before answering the questions.
2. This question paper consists of four (04) questions in five (05) pages.
3. **Answer all four (04) questions.** All questions carry equal marks.
4. Answer to each question should commence from a new page.
5. Draw fully labelled diagrams 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 on the front cover of your answer script.
9. Clearly state your **index number** in your answer script

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- 1.a. “Residence time” plays an important role in chemistry and especially in environmental science.
- i. Define the term “Residence Time” of a chemical species in the atmosphere?
 - ii. Water is supplied to the atmosphere by evaporation from the Earth surface and is removed by precipitation. If the total mass of water in the atmosphere is 1×10^{16} kg and the global mean average rate of precipitation to the Earth’s surface is 0.2 cm day^{-1} . Calculate the residence time of water in the atmosphere. Given that radius of the Earth is 6400 km and density of water 1000 kg m^{-3} .

(15 marks)

- b. The atmosphere, an extraordinary mixture of gases varying in reactivity and quantity, is categorized into layers based on temperature
- List the layered structure and major chemical composition of Earth's atmosphere.
 - Explain why the chemical components in each layer are crucial for life on our planet"

(30 marks)

- c. Stratospheric ozone is a layer of ozone gas, mostly concentrated in the stratosphere.
- Discuss the causes of ozone depletion and explain it's mechanism.
 - Discuss the distinct effects of increased UV-B radiation resulting from ozone depletion on human health, terrestrial plants, and aquatic life."

(25 marks)

- d. The use of fossil fuels for transportation and energy production has significantly increased the atmospheric concentration of the greenhouse gas CO₂. At present this gas alone is mostly responsible for the warming of Earth's atmosphere. Though ocean is an important sink for CO₂, its uptake is slow. One of the consequences of global warming is climate change which is very much evident in recent past.
- Defining the term 'sink' as applied in environmental chemistry and write down two sinks of carbon dioxide other than the ocean.
 - Defining the term 'Global Warming Potential' (GWP), briefly describe **three (03)** consequences of global warming.
 - GWP of methane is about 20 times more than that of carbon dioxide. Defining the term 'source' of a pollutant and write down **two (02)** sources of methane.
 - Write down an important sink of methane and write the chemical equation involved.

(30 marks)

- 2.a. Showing the typical thermal and oxygen profile graphs for oligotrophic and eutrophic lakes, write down the key difference between them.

(20 marks)

- b. The acidification of the earth and surface water has *devastating effects on ecosystems* and poses a danger to living beings.
- State the major causes for acid rain.
 - Explain the chemical reactions in the atmosphere that lead to the formation of sulfuric and nitric acids.

- iii. Calculate the approximate pH of rainwater in an area where the partial pressure of SO_2 in the atmosphere is 10 Pa. For SO_2 , Henry's Law constant $K_H = 1.0 \times 10^{-5} \text{ mol dm}^{-3} \text{ Pa}^{-1}$. For H_2SO_3 , $\text{pK}_{a1} = 3$. Assume that SO_2 is the only acidic species present in the atmosphere and the second association of H_2SO_3 is negligible.

(30 marks)

- c. Water quality is a crucial aspect of our daily lives, as it directly impacts our health and the functionality of our household systems. One important parameter to consider is water hardness.

- i. Briefly explain what is meant by the term water hardness.
- ii. Determine the total hardness as CaCO_3 of a sample of water that has calcium content of 28 mg/L and magnesium content of 9 mg/L.
- iii. How does water hardness affect the water quality?

(20 marks)

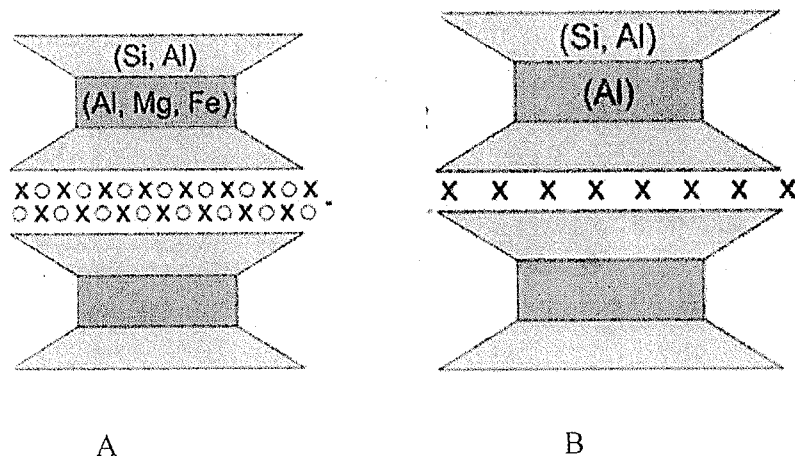
- d. Biochemical Oxygen Demand (BOD) is a vital parameter used to assess water quality.

- i. Discuss the significance of Biochemical Oxygen Demand (BOD).
- ii. Briefly describe the terms 5day-Biochemical Oxygen Demand (BOD_5) and ultimate Biochemical Oxygen Demand (uBOD).
- iii. A 5.0 mL sample of wastewater is diluted to 300.0 mL. The initial DO of the seeded dilution water is 8.7 mg/L, and the final DO is 4.8 mg/L. A control sample of only the dilution water has an initial DO of 8.9 mg/L and a final DO of 6.0 mg/L. Calculate the BOD_5 .

(30 marks)

3. a. Clay minerals are essentially aluminosilicates, and they form primarily through the chemical weathering of silicate minerals in rocks, a process that requires water.

- i. Discuss the fundamental crystal structures of the following clay mineral group A and B.



Note that circle indicates interlayer cation while the “cross” indicates the inter layer water molecule in this diagram.

- ii. Discuss the critical role of clay minerals in soil fertility. (20 marks)
- b. i. What is meant by physical weathering of rocks?
 ii. Compare and contrast physical and chemical weathering processes? (20 marks)
- c. Isomorphous substitution is a natural process in clay minerals which creates a negative charge on the surface of clay particles.
 i. Define the term “isomorphous substitution”
 ii. Explain how permanent negative charge is formed on the surface of clay mineral.
 iii. Explain its significant consequences of isomorphous Substitution. (30 marks)
- d. Modern industrialized societies have developed thousands of synthetic organic compounds such as plastics and pesticides etc. These synthetic chemicals contaminate the environment and pose threat to the natural ecosystem.
 i. Briefly discuss the key environmental impacts of pesticides.
 Soil organisms degrade many organic pollutants using various mechanisms. Briefly explain the following microbial degradation by giving example in each case.
 ii. Mineralization

iii. Detoxification

(30 marks)

4.a. Indoor air pollution is the presence of harmful substances in indoor air, with levels often two to five times higher than outdoor levels

- i. What is meant by the term “Indoor air”
- ii. Identify the sources of **three (03)** indoor air pollutants.
- iii. What is meant by threshold limit value (TLV) of indoor air pollutants?
- i. How does it relate to the nature of pollutants? Comment on the TLV (mg m^{-3}) of toluene (375) and benzene (30).

(30 marks)

b. Briefly discuss the environmental impacts of cultural eutrophication

(15 marks)

c. Acid mine drainage is a good example of mineral acidity of water bodies.

- i. What is meant by the term ‘mineral acidity’?
- ii. Discuss the chemistry of acid mine drainage.
- iii. Explain how the oxidation of sulfide minerals leads to low pH conditions and the mobilization of heavy metals and discuss the devastating impacts on aquatic ecosystems.

35 (marks)

c. State the possible water treatment process/ technique that could be used to treat the following contaminants.

- i. Pathogens
- ii. Organic carbon
- iii. Phosphate
- iv. Oils and Grease

(20 marks)
