

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 Title and - Code	: Environmental Chemistry – CYU 5309
Academic Year	: 2020/21
Date	: 09.12.2021
Time	: 9.30 a.m. – 11.30 a.m.
Duration	: 2 hours

General Instructions

1. Answer **any four (04)** questions.
2. If more than four questions are answered, only the first four answers will be marked.
3. Answer for each question should commence from a new page.
4. Draw fully labelled diagrams where necessary
5. Involvement in any activity that is considered as an exam offense will lead to punishment
6. Use blue or black ink to answer the questions.
7. Clearly state your index number in your answer script

1. a. Define the following terms as applied in Environmental Chemistry.

- | | |
|--------------------------|------------------------|
| i. Sink | ii. Primary pollutants |
| ii. Secondary pollutants | iv. Source |

(16 Marks)

b. Classify the following pollutants in the atmosphere as primary and secondary pollutant by giving a source and a sink for each pollutant.

- | | | |
|--------|--------------------|-----------------------|
| i. NO | ii. O ₃ | iii. N ₂ O |
| iv. CO | | |

(24 Marks)

c.i. What is meant by the term 'residence time'?

- ii. Calculate the residence time of nitrogen in the atmosphere using the data given below.

The mass of nitrogen in the atmosphere is 4×10^{18} kg and its sinks from the atmosphere include (1) biological nitrogen fixation by bacteria, 2×10^{11} kg yr⁻¹ (2) production of NO in thunderstorms, 7×10^{10} kg yr⁻¹ (3) chemical synthesis of ammonia 5×10^{11} kg yr⁻¹.

(10 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.

- i. Briefly describing the phenomenon that heats up the troposphere.
- ii. Draw and explain the temperature profile of the troposphere.
- iii. Give **two (02)** sinks of carbon dioxide other than the ocean.
- iv. Defining the term 'Global Warming Potential' (GWP), briefly describe **two (02)** consequences of global warming other than climate change.

(35 Marks)

- e. Explain **three (03)** human effects on the nitrogen cycle and predict the impact of these changes on an eco-system.

(15 Marks)

- 2.a.
 - i. What is meant by the term "thermal inversion"?
 - ii. Briefly describe how does thermal inversion influence air pollution?
 - ii. Give the name of **one** event (air pollution) that occurred due to temperature inversion.

(20 Marks)

- b. Catalytic converters are fitted into motor vehicle exhaust systems to reduce the emission of pollutants.
- i. List down the air pollutants that can be present in the vehicle exhaust.
 - ii. Explain using chemical equations, how these pollutants are produced in motor vehicles?
 - iii. How do catalytic converters convert the pollutants in the exhaust into harmless components?

(30 Marks)

- c.
 - i. What are freons?
 - ii. Describe how do they adversely affect the environment? Give equations to support your answer.

- iii. Ozone Depletion Potential (ODP) of CFC and related compounds are compiled to express the likelihood of destruction of stratospheric ozone. Explain why the ODP of CHFCl_2 (0.40) is lower than that of CFCl_3 .
(30 Marks)
- d. i. "Water has the highest specific heat capacity". What do you understand by this statement? Identify biological importance of the specific heat capacity of water.
ii. One of the physical property of water is turbulence. How does turbulence affect aquatic organism?
(20 Marks)
- 3.a. i. Briefly explain what is meant by 'acid rain'?
ii. If burning of coal is the only source of acidic oxides, briefly describe the formation of acid rain.
iii. Write **three (03)** adverse effects of acid rain on the environment.
(30 Marks)
- b. Lake is a waterbody completely encapsulated by land.
i. Compare and contrast oligotrophic lakes with eutrophic lakes.
ii. Draw a characteristic vertical profile of dissolved oxygen of a eutrophic lake.
iii. What are the importance of dissolved oxygen in aquatic systems?
iv. The concentration of O_2 in water at equilibrium with pure gaseous O_2 at a pressure 1.00 atmosphere is $1.3 \times 10^{-3} \text{ mol.dm}^{-3}$ at 25°C . What is the concentration of O_2 dissolved in water at equilibrium with air at the same temperature? [Partial Pressure of O_2 is 0.21 atmosphere]
(40 Marks)
- c. Environmental Chemists use the concept of pE to characterize the extent to which natural waters are chemically oxidizing/reducing in nature.
i. Define the term pE.
ii. What are the uses of a pE-pH diagram?
iii. You are given the pE^0 value for the following redox reaction.

$$\frac{1}{4} \text{O}_2 (g) + \text{H}^+ + e^- \leftrightarrow \frac{1}{2} \text{H}_2\text{O} \quad \text{pE}^0 = 20.75$$
Estimate pE for the aquatic habitat water of a lake having dissolved O_2 with a partial pressure of 6×10^{-4} atmosphere and a pH of 7.0 at 25°C .
iv. Explain briefly the phenomenon "thermal stratification" of lakes. Explain how pE will vary with depth in a stratified lake.
(30 Marks)

- 4.a. i. What do you understand by the term alkalinity of water?
ii. What is the alkalinity (as mg/L CaCO_3) of water containing 80 mg/L bicarbonate and 15 mg/L carbonate? [Relative atomic weight: C=12; O=16; H=1]
- (20 Marks)**
- b. i. Define the term "Chemical Oxygen Demand" (COD) of a water.
ii. Differentiate COD from Biochemical oxygen Demand (BOD)
iii. A 2.0 mL portion of river water sample was diluted to 300.0 mL, and aerated. The dissolved oxygen content was 7.8 mg/L initially. After 5 days, the dissolved oxygen content had dropped to 5.9 mg/L. What is the BOD_5 of this sample?
- (40 marks)**
- c. Explain the role of Poly chlorinated benzenes (PCB) in environmental pollution.
- (10 Marks)**
- d. Acid mine drainage is a good example of mineral acidity.
i. What is meant by mineral acidity?
ii. Explain by giving appropriate chemical equation, the environmental problems associated with acid mine drainage.
- (30 Marks)**
5. a. By giving examples briefly discuss environmental significance of chelating agents on aquatic systems.
- (30 Marks)**
- b. Detergents are cleaning agents.
i. Explain by giving examples the role and environmental significance of Surfactant
ii. What is the reason that soap is environmentally less harmful than other surfactants used in detergent?
- (20 Marks)**
- c. Briefly describe the following processes.
i. Incineration of wastes and its environmental significance
ii. Disinfection of water by chlorine
- (30 marks)**

- d. Briefly discuss the important physical processes that takes place in wastewater treatment.

(20 Marks)

- 6.a. i. What is soil organic matter?
ii. Why is it considered as the important soil component for plant growth?
iii. What is humus? Give at least **three (03)** importance of humus.

(30 marks)

- b. i. Define the term 'Cation Exchange Capacity' (CEC) of soil.
ii. Explain how CEC maintains soil fertility.

(20 marks)

- c. i. What is meant by the term 'soil pollution'?
ii. Give major routes of soil pollution.
iii. Briefly explain how soil pollution leads to air and water pollution.

(20 marks)

- d. Describe **three (03)** mechanisms that are used by the microbes to degrade and transform of organic contaminants in soil. Give **one (01)** example in each case.

(30 marks)

