



The Open University of Sri Lanka

B.Sc. Degree Programme

Environmental Chemistry- CYU5309/CMU3129

Final Examination- 2017/18

Duration- Two (02) Hours

Date: 18.09.2018

Time: 9.30 a.m. – 11.30 a.m.

ANSWER ANY FOUR (04) QUESTIONS

If more than four questions are answered, only the first four answers will be marked.

1.a 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, draw and explain the temperature profile of the troposphere.
- ii. Defining the term 'sink', write down two sinks of carbon dioxide other than the ocean.
- iii. Defining the term 'Global Warming Potential' (GWP), briefly describe two consequences of global warming other than climate change.
- iv. GWP of methane is about 20 times more than that of carbon dioxide. Defining the term 'source' of a pollutant, write down two sources of methane. Write down the equations to show an important sink of methane.

(75 marks)

b. Draw the oxygen cycle and briefly explain how anthropogenic activities can affect it.

(25 marks)

2. a. Ozone plays a beneficial role in the stratosphere while in the troposphere it is an oxidant and a secondary pollutant and harmful for humans and vegetation, and an air quality standard is needed. In Sri Lanka the maximum permissible level of ozone in the atmosphere is 0.10 ppm.

- i. Write down equations for Chapman mechanism for the formation and destruction of stratospheric ozone.
- ii. Draw the vertical profile of ozone in the stratosphere showing the levels of ozone at various altitudes.
- iii. Briefly describe the beneficial effect of stratospheric ozone.
- iv. Defining the term 'residence time', explain the characteristic(s) of chlorofluorocarbons (CFCs) that give them long atmospheric lifetimes.
- v. Ozone is a component of photochemical smog which is considered as an important pollution phenomenon due to increasing vehicular emissions.
(α) Write the conditions necessary for photochemical smog
(β) Briefly describe the adverse effect(s) of ozone
(γ) Write down other components of photochemical smog.

(70 marks)

- b.
 - i. What do you mean by 'acid rain'?
 - ii. Identifying the sources of acidic oxides, write equations to show the formation of acid rain.
 - iii. Briefly describe the adverse effects of acid rain on vegetation and natural waters.

(30 marks)

3.a. Explain the biological significance of the following.

- i. Water has the highest specific heat capacity
- ii. Water is an excellent solvent
- iii. Water has a high enthalpy of fusion

(15 Marks)

- b. i. Draw a diagram showing thermal stratification of a lake.
 ii. Describe the changes that take place during autumn in a thermally stratified lake.
(25 Marks)
- c. i. What is meant by the term 'cultural eutrophication'?
 ii. Describe the process of Cultural eutrophication and evaluate the impacts of it.
(25 Marks)
- d. i. Define Dissolved oxygen (DO) in a water body and give its value to be maintained in an aquatic system.
 ii. Explain in detail the oxygen sag curve.
 iii. Determine the 5-day BOD (Biochemical Oxygen Demand) for a 15.0 ml sample that is diluted with dilution water to a total volume of 300.0 ml when the initial DO concentration is 16 mg/L and after 5 days, has been reduced to 4 mg/L.
(35 Marks)

4.a. Describe the following terms as applied in Environmental Chemistry.

- i. Alkalinity of a water body
 ii. Hardness of water

A sample of water contains the following ions.

Ions	Concentrations (mg/L)	Ions	Concentrations (mg/L)
Ca^{2+}	115.3	HCO_3^-	260
Mg^{2+}	39.2	SO_4^{2-}	110
Na^+	7.1	Cl^-	59
K^+	14	CO_3^{2-}	13.5

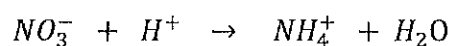
- iii. Calculate the hardness and alkalinity of the sample in milligrams of CaCO_3 per Liter [Atomic weight (g/ mol) C =12; H =1; O =16; Ca = 40; Mg = 24; Na = 23; K = 39; S = 32].

(40 marks)

- b. i. Cation exchange capacity is an important phenomena. Define the term "Cation exchange capacity (CEC) of soil.
- ii. State **two** important aspects of CEC in soil.

(20 Marks)

- c. i. Describe what is meant by the term pE?
- ii. What does a negative pE value implies about the aquatic system?
- iii. Deduce the equilibrium ratio of concentrations of NO_3^- to NH_4^+ at a pH 6.0 for anaerobic water with pE -3. Given that the pE° for the following reaction is +14.9.



(40 Marks)

- 5.a. Acid mine drainage is a good example of mineral acidity. Explain by giving appropriate chemical equation, the environmental problems associated with acid mine drainage.

(20 Marks)

- b. Calculate the concentration and pH of a sample of club soda which is made from pure water bottled under a pressure of 2.02×10^5 Pa of CO_2 (g) at 25°C . Given that K_{H} for CO_2 (g) is $3.3 \times 10^{-7} \text{ mol L}^{-1} \text{ Pa}^{-1}$ at 25°C and the dissociation constant K_{a1} for of H_2CO_3 is $4.45 \times 10^{-7} \text{ mol L}^{-1}$. Assume that dissociation constant K_{a2} for HCO_3^- is negligible.

(30 marks)

- c. Explain the action of chlorine when mixed with water and briefly describe how the disinfection of water by chlorine takes place.

(30 Marks)

- d. Discuss the advantages and disadvantages of incineration of solid waste.

(20 Marks)

- 6 . a. i. Define the term "Chemical Oxygen Demand" (COD) of a water.
- ii. It was found that 20.8 mL of ^{0.001}0.001 M $\text{Na}_2\text{Cr}_2\text{O}_7$ was required to titrate a 40.0 mL of a wastewater sample. Calculate COD (in mg of oxygen / liter) of the wastewater sample [Atomic weight; O = 16 g/mol].
- (35 Marks)
- b. Describe **three** mechanisms that are used by the microbes to degrade and transform of organic contaminants in soil. Give **one** example in each case.
- (30 marks)
- c. i. Chemical coagulation is an important step in primary treatment of wastewater. What is meant by the term 'chemical coagulation'?
- ii. Give **four** common coagulants used in treatment plant.
- iii. Describe the functions of the coagulants in the treatment of wastewater.
- (20 Marks)
- d. List down the possible treatment process/ techniques that could be used to treat the following contaminants.
- i. Pathogens
- ii. Organic carbon
- iii. Phosphate
- (15 Marks)
