



The Open University of Sri Lanka

B.Sc. Degree Programme

Environmental Chemistry- CYU5309/CMU3129

Final Examination- 2017/18

Duration- Two (02) Hours

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Date: 18.09.2018

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 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 CO<sub>2</sub>. At present this gas alone is mostly responsible for the warming of Earth's atmosphere. Though ocean is an important sink for CO<sub>2</sub>, 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.
  - ( $\alpha$ ) Write the conditions necessary for photochemical smog
  - ( $\beta$ ) Briefly describe the adverse effect(s) of ozone
  - ( $\gamma$ ) 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 <sup>2+</sup>	115.3	HCO <sub>3</sub> <sup>-</sup>	260
Mg <sup>2+</sup>	39.2	SO <sub>4</sub> <sup>2-</sup>	110
Na <sup>+</sup>	7.1	Cl <sup>-</sup>	59
K <sup>+</sup>	14	CO <sub>3</sub> <sup>2-</sup>	13.5

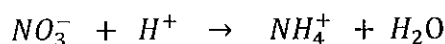
- iii. Calculate the hardness and alkalinity of the sample in milligrams of CaCO<sub>3</sub> per Liter [Atomic weight (g/ mol) C =12; H =1; O =16; Ca = 40; Mg = 24; Na = 23; K = 39; S = 32].

(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  $\text{NO}_3^-$  to  $\text{NH}_4^+$  at a pH 6.0 for anaerobic water with pE -3. Given that the  $\text{pE}^\circ$  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  $2.02 \times 10^5$  Pa of  $\text{CO}_2$  (g) at  $25^\circ\text{C}$ . Given that  $K_{\text{H}}$  for  $\text{CO}_2$  (g) is  $3.3 \times 10^{-7} \text{ mol L}^{-1} \text{ Pa}^{-1}$  at  $25^\circ\text{C}$  and the dissociation constant  $K_{\text{a}1}$  for of  $\text{H}_2\text{CO}_3$  is  $4.45 \times 10^{-7} \text{ mol L}^{-1}$ . Assume that dissociation constant  $K_{\text{a}2}$  for  $\text{HCO}_3^-$  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 0.01 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)

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