The Open University of Sri Lanka

B.Sc. Degree Programme – 2013/14

Environmental Chemistry –CMU 3129

FINAL EXAMINATION

Duration: Two (02) Hours

Date: 09.06.2014. **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. i. Define the terms, 'source' and 'sink' as used in environmental chemistry. Write the source(s) and sink(s) of stratospheric ozone.

ii. Giving examples, distinguish between primary pollutants and secondary pollutants in the atmosphere.

iii. What do you mean by the term 'residence time'? Calculate the residence time of water in the ocean, given that the volume of the ocean is 1.4×10^9 km^3 and the river influx is 3.7×10^5 km^3/yr.

(45 marks)

b. i. Sketch and explain the temperature profile of the atmosphere from the Earth up to 50 km. Write the important characteristics of the regions.

ii. What do you mean by "temperature inversion"? Draw the temperature profile to show the change(s) due to a temperature inversion.

(55 marks)

2.a. i. What is meant by 'acid rain'? Write the sources of acid rain. Briefly describe **three** adverse effects of acid rain on the environment.

ii. Compare **five** different characteristics of London-type smog and Los Angeles – type smog.

(50 marks)

b. What do you mean by 'TLV' of indoor air pollutants? How does it relate to the nature of pollutants? (20 marks)

c. i. Write **three** unique properties of water and their significant effect upon the life on the Earth.

ii. What is meant by mineral acidity as applied in an aquatic system? Give **two** examples for mineral acidity. (30 marks)

3.a. i. What do you mean by 'global warming potential (GWP)'? Compare the global warming potentials of CO_2 and CH_4.

ii. Briefly describe **three** major consequences of global warming.

(40 marks)

b. i. What is hardness in water and by what is it caused?

ii. Calculate the total hardness (in mg $CaCO_3$ / L) of water containing the following cations (in mg/L), Na^+ - 20; Ca^{2+} - 15; Mg^{2+} - 10 Sr^{2+} - 2.

[Atomic mass (g mol^{-1}) Na = 23; Ca = 40; Mg = 24; Sr = 87.6; C=12; O=16]

iii. What are the undesirable effects of hardness?

iv. Briefly explain the lime soda process which can be used to remove permanent hardness.

(40 marks)

c. i. What is meant by 'nutrient pollution' in an aquatic system?

ii. What are the sources for nutrient pollution?

iii. What are the **two** most important nutrients involved in this pollution?

iv. Give **two** adverse effects of nutrient pollution on an aquatic system.

(20 marks)

4. a. i. State Henry's law.

ii. Calculate the pH of CO_2 – saturated water at 25°C, given that the partial pressure of CO_2 in air is 3.5×10^{-4} atmosphere, and that for CO_2 the Henry's constant K_H

$= 3.4 \times 10^{-2}$ mol L^{-1} atm^{-1} at 25°C; the ionization constant K_a, for H_2CO_3 has a value of 4.5 x 10 mol L^{-1} at this temperature.

(30 marks)

b. i. Define pE of an aqueous solution.

ii. What does a high pE value imply about a solution?

Consider the conversion of SO_4^{2-} to H_2S in an acidic solution.

iii. Write down a balanced equation for this reduction reaction.

iv. Write down the balanced equation for the one electron mole.

v. Deduce the expression relating to pE to pH,$[SO_4^{2-}]$, and P_{H_2S}.

vi. Calculate the partial pressure of H_2S when the $[SO_4^{2-}]$ is 10^{-5} M and the pH is 6.0 for solution that is in equilibrium with atmospheric O_2.

[pE^o for the above mentioned reduction reaction is = 5.75; For any solution is equilibrium with atmospheric O_2, at pH 6, pE = +14.5].

(70 marks)

5.a. i. What do you understand by the term 'alkalinity of a water sample?

ii. The alkalinity of a river sample was determined to be 5×10^{-3} mol H^+ /L and its pH is 8.0. Calculate the concentrations of CO_3^{2-} and HCO_3^- in the river.

The second dissociation constant for of H_2CO_3 is 4.69×10^{-11} mol /L.

(30 marks)

b. i. Define the terms Biochemical Oxygen Demand (BOD) and Chemical oxygen Demand (COD).

ii. Explain why the values of BOD and COD for the same water sample can differ slightly.

iii. Calculate the COD value of industrial wastewater sample containing 400 mg/L of stearic acid $C_{18}H_{36}O_2$. [Relative atomic mass: C=12, O=16; H=1]

(40 marks)

c. i. Give **three** major changes that occur during aerobic process in the secondary wastewater treatment.

ii. Explain how surfactants from detergents affect water treatment process.

(30 marks)

6.a. Tetrahedrons and octahedrons are the building blocks of layer silicate clays. These building blocks are arranged to form sheets. According to these sheets arrangement Clay minerals can be classified as 1:1 and 2:1 minerals.

i. What is the central element in each of tetrahedrons and octahedrons?

ii. Briefly explain what do you understand by 1:1 and 2:1 minerals? Give **one** example of each mineral.

(20 marks)

b. i. What is meant by acidification of soil?

ii. What are the major sources of soil acidity?

iii. What are the consequences of soil acidity?

iv. Give **two** compounds that are commonly used to neutralize acid soils.

(20 marks)

c. i. What is soil organic matter?

ii. Why it is important soil component for plant growth?

iii. What is humus? Give at least **three** importances of humas.

(20 marks)

d. i. What is composting?

ii. Why it is important?

iii. What are the parameters which control the optimum composting operation?

iv. What is meant by the concept carbon to nitrogen ratio?

(40 marks)