THE OPEN UNIVERSITY OF SRI LANKA

B.Sc DEGREE PROGRAMME/ STAND ALONE COURSES IN SCIENCE

ENVIRONMENTAL CHEMISTRY- CHU3122/CHE5122

FINAL EXAMINATION- 2012/13

Duration: Two hours

Date: 07.12.2013 (Saturday) **Time: 9.30 a.m.- 11.30 a.m.**

1. The atmosphere and its constituents perform important functions to sustain life on the planet Earth. However, over the years, it has been at the receiving end for most of the pollutants that humans produce. Some of these have far reaching consequences affecting climate and weather patterns while the others have affected public health.

   (i) Write the three major constituents in the atmosphere.
   (ii) Briefly describe four important functions of the atmosphere.
   (iii) Identifying the main contributors, briefly describe the principal phenomena that warm the troposphere and stratosphere.
   (iv) Sketch the temperature profile of the atmosphere up to 50 km. Identify the boundaries in the diagram. (100 marks)

2. (a) Oxygen is an important element that exists in the atmosphere; it has two allotropes: dioxygen (or molecular oxygen), O_2 and ozone, O_3.

   (i) Define the terms, 'source' and 'sink' as used in environmental chemistry.
   (ii) Write the source(s) and sink(s) of molecular oxygen in the atmosphere.
   (iii) Write down the mechanism by which O_3 is formed in the stratosphere.
   (iv) Briefly describe the beneficial role played by ozone in the stratosphere.
   (v) Breakdown of ozone in the stratosphere is catalysed by NO, OH and other radicals. Write down the mechanism for the destruction of ozone by CF_2Cl_2. (60 marks)

   (b) Increased levels of greenhouse gases (GHG) have given rise to increase in global temperature in what we call 'global warming'. Methane, CO_2 and CFCs are well known GHGs.

   (i) Write the source(s) and sink(s) of methane.
   (ii) Briefly describe the consequences of global warming. (40 marks)

3. (a) Vehicular emission is a major cause of pollution in developing economies, where public transport is not supported by their governments. As a result of an alarming increase in the number of vehicles on the roads, with subsequent increase in emissions, the cities become blacked out by 'smoggy' atmosphere when the conditions are right for them. The Los Angeles (LA) smog is one such condition which caused great environmental hazards.

(i) Write the constituent(s) in vehicle exhaust that is responsible for LA smog.
(ii) Identify the nature of LA smog.
(iii) Write the conditions necessary for the formation of LA smog.
(iv) Outline the physical characteristics of the LA smog.
(v) Peroxy acyl nitrate (PAN) is a component present in the LA smog. Name the others present. Briefly describe a health effect of PAN. (70 marks)

(b) When Sri Lanka decided to build the coal power plant in Norachcholai, there was genuine concern expressed by environmentalists for the hazards that it would pose. One such hazard cited was probable 'acid rain' and its detrimental effects on nature. However, the power plant is now completed, with the assurance that every step has been taken to address the concerns expressed.

(i) What is meant by 'acid rain'?
(ii) Write equation(s) to show how emissions from the coal power plant can contribute to acid rain.
(iii) Briefly describe three adverse effects of acid rain on the environment. (30 marks)

4. (a) Water plays an important role in sustaining aquatic life.

(i) Write down three unique properties of water and their significance in aquatic life.
(ii) What is meant by the term 'productivity' of a water body and briefly explain how it is related to water quality. (30 marks)

(b)(i) What do you understand by the term 'thermal stratification'?
(ii) Draw a labelled diagram to show stratification of a lake in the summer and indicate the typical forms of the main elements in it. (30 marks)

(c)(i) Define the term, 'alkalinity' of a water body.
(ii) Why alkalinity is important for a water body?
(iii) A 50.0 cm^3 sample of water required 15.20 cm^3 of 0.01 M H_2SO_4 to reach the methyl orange end point. Calculate the total alkalinity of the water sample in
(I) meq $H^+ L^{-1}$
(II) mg $CaCO_3 L^{-1}$ (40 marks)

5. (a)(i) Write down the mathematical form of Henry's Law and identify the terms in it.
(ii) Calculate the *pH* of CO_2- saturated water at 25 ^{0}C, given that the partial pressure of CO_2 in air is 3.5×10^{-4} atmosphere and the Henry's Law constant K_H for CO_2 is 3.4×10^{-2} mol L^{-1} atm^{-1} at 25 ^{0}C; the ionization constant K_a for H_2CO_3 has a value of 4.5×10^{-7} mol L^{-1} at this temperature. (30 marks)

(b)(i) Define the term Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).
(ii) Explain why their values for the same water sample can differ.

(iii) A polluted water sample is suspected of being contaminated with ABS (Alkyl Benzene Sulphonate) or LAS (Linear Alkyl Sulphonate). The sample has a very low BOD relative to its COD. Identify the contaminant. Explain your answer.

(iv) Calculate the COD of industrial wastewater sample containing 400 mg L^{-1} of stearic acid $C_{18}H_{36}O_2$. (Atomic weight: H = 1; C = 12; O = 16)

(40 marks)

(c)(i) What are PCBs?

(ii) Write down its properties, sources and uses.

(iii) Why is PCB considered as water pollutant? (30 marks)

6. (a)(i) What are detergents?

(ii) What is role phosphate builder used in detergents?

(iii) Give two examples of phosphate builder.

(iv) What is the environmental effect by the presence of significant amount of phosphate in water?

(v) What are the environmental consequences resulting from this effect?

(40 marks)

(b)(i) Give the mathematical expression for *pE*.

(ii) What are the uses of a *pE- pH* diagram?

(iii) What does the negative *pE* value imply about the system?

(iv) Calculate the ratio of equilibrium concentrations of NH_4^+ to NO_3^- at $pH = 6$ in a sample of aerobic water having a *pE* value of +11, given that E^0 value for

$$1/8\ NO_3^- + 5/4\ H^+ + e \rightleftharpoons 1/8\ NH_4^+ + 3/8\ H_2O \quad \text{is } 0.882\ V$$

(40 marks)

(c) Soil *pH* is an important property that influences many chemical and biological procedures occurring in soil. Acidification can occur due to acid rain. How does acid rain affect soil? Give two examples. (20 marks)

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