The Open University of Sri Lanka

B.Sc. Degree Programme – 2012/201.

ENVIRONMENTAL CHEMISTRY - CMU 3129

MODEL FINAL EXAMINIATION PAPER

Duration 2 hours

Date: **Time:**

Answer any four (04) Questions

1. a. According to variation of temperature with altitude, the atmosphere is divided into four major strata (layers), the characteristics of which differ widely. The two strata closer to the Earth surface show considerable chemical and photochemical reactivity.

   i.   Identify the two strata closer to the Earth's surface.

   ii.   Describing the variation of temperature within these strata, sketch the temperature profile of these two strata. Indicate the characteristic of these strata.

   iii. Write the major phenomen(on/a) that is /are associated with each of these strata.

   (70 marks)

   b. i. Write two important sources of CH_4. What is the environmental consequence of increased levels of methane in the atmosphere?

   ii. Briefly describe the major sink of CH_4 in the atmosphere.

   (30 marks)

2. a. We all know that the atmosphere contains 78% nitrogen by volume; it is an inexhaustible reservoir of that essential element. Atmospheric nitrogen is fixed and subsequently returned to the atmosphere as gaseous molecular nitrogen in the nitrogen cycle.

   i.   Draw the nitrogen cycle.

   ii.   Explain the terms atmospheric fixation, biological fixation and industrial fixation of nitrogen.

   (40 marks)

   b. Greenhouse gases are responsible for keeping our planet warm and thus sustaining life on Earth. Carbon dioxide and water vapour are such gases.

i.   Briefly explain, with an example, the difference between the "anthropogenic greenhouse effect" and the natural greenhouse effect'.

ii.   Why does the term 'greenhouse effect' not mean the same as global warming?

(30 marks)

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

ii.   Calculate the total alkalinity for a sample of a river whose phenolphthalein alkalinity is known to be 3.0×10^{-5} mol dm^{-3}, whose pH is 10.0 and bicarbonate ion concentration is 1.0×10^{-4} mol dm^{-3}.

(30 marks)

3.a.   When the atmosphere is loaded with quantities of automobile exhausts during warm sunny days with gentle winds and low level inversion, the exhaust gases are trapped and simultaneously exposed to intense sunlight. Then a series of photochemical reactions takes place giving rise to the phenomenon of 'photochemical smog'.

i.   Name the vehicle exhausts

ii.   What are the components that contribute to photochemical smog?

iii. Write the physical characteristics of photochemical smog.

iv.   Briefly describe the effects of photochemical oxidants on humans, plants and materials.

(40 marks)

b.   i.   What is meant by the term "Dissolved Oxygen"(DO)?

ii.   What is the importance of (DO)?

iii. Fish need at least 5 ppm dissolved O_2 for survival.

(α) What is this concentration in mol/dm^3?

(β) What partial pressure of O_2 above the water is needed to obtain this concentration at 25^{0}C?

(The Henry's law constant for O_2 at 25^{0}C is 1.3 mol dm^{-3} Pa^{-1}

(30 marks)

c.   i.   How are solid wastes classified?

ii.   Discuss the advantages and disadvantages of incineration process of solid waste.

(30 marks)

4.a.   i.   What is meant by acid rain?

      ii.   What are the anthropogenic sources of acid rain?

      iii.   Briefly describe the effects of acid rain on materials.

      iv.   The concentration of Al^{3+} in natural waters normally is quite small; however it increases in the presence of acids.

          (α)   What is the adverse effect of high concentration of Al^{3+} on fish?

          (β)   By what factor will the concentration of Al^{3+} increase when pH decreased from 5 to 4?

(50 marks)

   b.   i.   What is meant by the pE of an aqueous solution?

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

      iii.   Consider the reduction of nitrate ion in an acidic aqueous to ammonium ion.

     1. Write a balanced equation for the **one electron half reaction** for the process.

     2. Given that for this reaction, $E^0 = 0.880$ volts, calculate pE^0.

     3. Deduce a relationship of pE to p E^0 for the above half reaction.

     4. From expression in part (3), obtain an equation relating the pE to pH under conditions in which the concentration of $NO_3 = NO_2$.

     5. What will be the pE under condition of pH = 5?

(50 marks)

5. a.   Describe the process of eutrophication?

(10 marks)

   b.   i.   What is hard water?

      (ii)   Differentiate between temporary and permanent hardness.

      (iii)   Permanent hardness can be removed by adding washing soda, Na_2CO_3 .$10H_2O$, to the water to precipitate calcium carbonate which can then be removed by filtration. Calculate the mass of washing soda required to soften 1000 litres of hard water containing 250 mg L^{-1} Ca^{2+}.

      (Relative atomic mass: Na = 23 , C = 12 , O =16 , H = 1)

(40 marks)

c. i.   What is recycling?

    ii. Why is it so important to recycle?

(20 marks)

d. i.   What are the functions of soil?

    ii. What is meant by soil profile? Discuss the characteristic features.

    iii. Discuss the importance of soil organisms to maintain the quality of soil.

30 Marks)

6.a. i.   What are the soil forming rocks?

      ii. Discuss the process of formation of soil.

10 marks)

b. i.   What is soil organic matter?

    ii. Why is it an important soil component?

    Iii What is humus?

20 marks)

c. i.   Explain the importance of colloidal matter in terms of maintaining quality of soil.

    ii. Explain the nature of cation retention and mechanism of cation exchange in soils.

    iii. Soil reaction varies due to various factors. Briefly discuss the factors controlling soil reactions.

(40 marks)

d. i.   What is composting? Why it is important?

    ii. Briefly explain composting ?

    iii What are the important control parameters for an optimum composting operation?

(30 marks)