THE OPEN UNIVERSITY OF SRI LANKA

B. Sc . / B. Ed. DEGREE PROGRAMME /STAND ALONE COURSES IN SCIENCE

CHU 3122 / CHE 3122 /CHI 3122/CHI 3122 – LEVEL 5

FINAL EXAMINATION – 2009/2010

(2 ½ hours)

DATE: 07.01 2010   **TIME : 1.30 p.m.– 4.00 p.m.**

1. The atmosphere is an envelope of gases surrounding the Earth. It shows varying characteristics with increasing altitude and forms important functions. Unfortunately, the atmosphere has been a reservoir to receive many pollutants.

   (a) Write the components of the unpolluted atmosphere, in the decreasing order of concentration.

   (b) Identifying the components, indicate the important functions of the atmosphere.

   (c) Explain what you mean by 'greenhouse effect' and describe the consequences of global warming.

   (d) Defining the terms "source" and "sink" as used in environmental chemistry, briefly describe the sources, sinks and environmental effects of CO, CH_4 and CFC.

   (100 marks)

2. (a)(i) Draw the temperature structure of the atmosphere up to 50 km and indicate the characteristics of the region(s).

   (ii) Write the sources and sinks of atmospheric oxygen. Identify the anthropogenic activities that can affect the oxygen cycle.

   (40 marks)

   (b)(i) Write balanced chemical equation to show how SO_2 and NO_2 contribute to acid rain formation.

   (ii) Discuss the effects of acid rain.

   (iii) The pH in a lake of size 3.0 km x 8.0 km and an average depth of 100 m is found to be 4.65. Calculate the mass of calcium carbonate that must be added to the lake water in order to raise its pH to 5.5. Assume that the reaction of H^+ with $CaCO_3$ (Molecular weight = 100 g mol^{-1}) gives bicarbonate ion: $H^+ + CO_3^{2-} \rightarrow HCO_3^-$.

   (45 marks)

   (c) Briefly describe the sources and health effects of PAH in the atmosphere.

   (15 marks)

3. (a) Consider this graph showing the variation of concentrations of hydrocarbon and ozone with time for a major Metropolitan area.
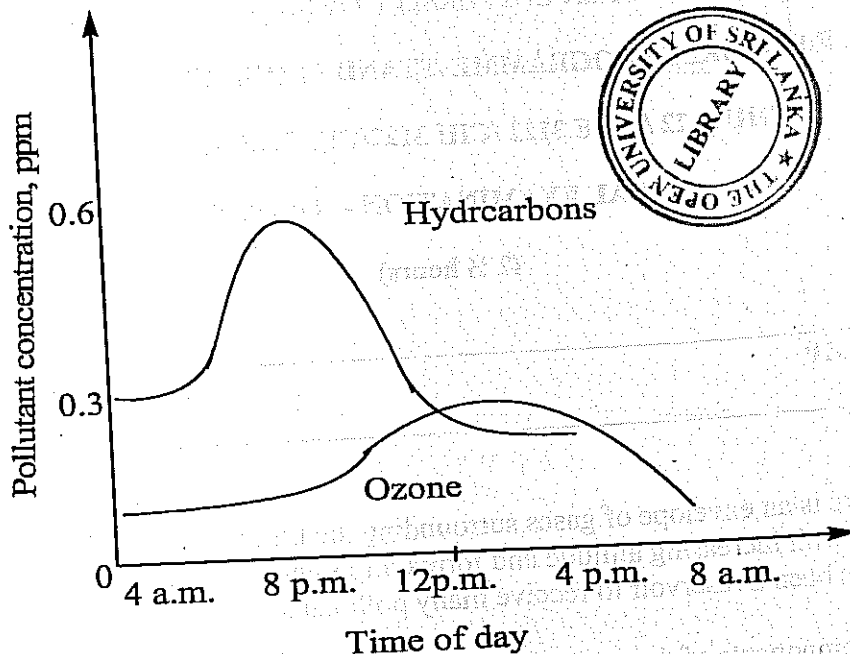
Answer the following questions:

(i) Interpret the two curves, explaining what they imply about air pollution in an urban area.

(ii) Sketch the given graph and indicate the curve for NO in it.

(iii) Identifying the conditions necessary for the above environmental problem, indicate three other major pollutants formed. Write the source(s) of ozone.

(iv) What type of health effects would be observed in this major metropolitan area?

(50 marks)

(b)(i) Briefly explain what is meant by the threshold limit value, TLV.

(ii) Explain the effects of exposure to mixtures of airborne toxic substances on human health.

(iii) Describe whether the TLV is exceeded in each of the following cases:

    (I) SO_2 (1.6 ppm) and Cl_2 (0.9 ppm)

    (II)   Benzene (1.5 ppm) and Toluene (85 ppm)

    TLV for Cl_2 = 1.5; SO_2 = 5; benzene = 30; toluene = 375.

(Hint: Benzene and toluene are similar in effects while SO_2 and Cl_2 are dissimilar).

(50 marks)

4.(a)(i) Define the terms 'Alkalinity' and 'Chemical Oxygen Demand' (COD).

(ii) How is COD measured?

(iii) Calculate the COD of a solution containing 425 mg dm^{-3} potassium hydrogen phthalate ($KC_8H_5O_4$).

Molecular weight of potassium hydrogen phthalate = 204 g/mol ; O_2 = 32 g/mol.

(30 marks)

(b)(i) What are the main sources of phosphate ion in natural waters?

(ii) What phosphate is used in detergents?

(iii) What are the distinct advantages that soap has as a cleaning agent?

(iv) Identify the main characteristics of radionuclides that make them especially hazardous to human.

(40 marks)

(c)(i) State the ions which cause the hardness in water.

(ii) Explain how limestone introduces hardness to water.

(iii) Describe the removal of temporary hardness from water by ion exchange method.

(30 marks)

5.(a)(i) What is meant by the pE of an aqueous solution?

(ii) What does a low pE value imply about the solution?

(10 marks)

(b) Consider the reduction of nitrate ion in an acidic aqueous solution to nitrite ion.

(i) Write a balanced equation for the one-electron half – reaction for the process.

(ii) Given that for this reaction, $E^0 = + 0.881$ volts, calculate pE^0.

(iii) Deduce a relationship of pE to pE^0 for the above half reaction.

(iv) From the expression in part (iii), obtain an equation relating the pE to pH under conditions in which the ratio of nitrate to nitrite is 100:1.

(v) What will be the ratio of nitrate to nitrite under conditions of pE = 12, pH = 5.

(50 marks)

(c)(i) State and write the mathematical expression for the Henry's law.

(ii) What is the importance of dissolved oxygen (DO) in water?

(iii) The DO in a water sample was determined and found to be 3.8 mg/l. The temperature of the sample was 15^0C and pressure was 1 atm. Calculate the percent saturation of DO in the water sample, given that Henry's law constant for O_2 at $15\ ^0C$ is $1.5 \times 10^{-3}\ mol\ dm^{-3}\ atm^{-1}$. Concentration of oxygen in air is 20.95%. Assume that the salinity does not affect the DO concentration.

(40 marks)

6.(a)(i) Describe the 'itai- itai' disease and 'Minamata' disease in relation to their origin, source(s) and the symptoms.

(ii) List a metal ion and/or a ligand that can be present in wastewater from each of the industries: electroplating, food and beverages, textile and leather tanning. Indicate the environmental consequences of these pollutants in the water body.

(65 marks)

(b) A water sample from a polluted well was analysed for Cd^{2+} and Pb^{2+} concentration. $50.00\ cm^3$ sample required $40.10\ cm^3$ of $0.005\ mol\ dm^{-3}$ EDTA for the titration. A $75.00\ cm^3$ portion of the same sample was made basic and treated with excess KCN, masking the cadmium ions as $Cd(CN)_4^{2-}$. This solution required $31.40\ cm^3$ of the EDTA for the titration. The toxic levels (ppm) of Cd^{2+} and Pb^{2+} in drinking water are considered as 0.005 and 0.01 respectively. Assuming that the two metal ions contribute independently to health effects, assess the suitability of the water from this well for human consumption.

(35 marks)

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