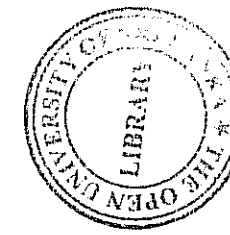
THE OPEN UNIVERSITY OF SRI LANKA
B.Sc./B.Ed. DEGREE PROGRAMME -2009/2010
ENVIRONMENTAL CHEMISTRY – LEVEL 5
CHU 3122/ CHE 5122



ASSIGNMENT TEST I

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Date: 26.09.2009 (Saturday) **Time: 4.00pm – 5.30pm**

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Answer all questions

1. a. (i) How do you define the following terms?
Pollutants
Receptor
Source
Geosphere

(20 marks)

b.(i) Briefly explain what is meant by acid rain.
(ii) Write balanced equations to show how SO_2 and NO_2 contribute to acid rain formation.
(iii) Briefly explain how acid rain affects fish, trees and building materials.

(30 marks)

c. (i) Write down five of the trace components of the atmosphere.
(ii) Indicate a component which is formed by lightening?
(iii) Indicate the one which is radioactive?

(20 marks)

d. (i) What are green house gases?
(ii) Briefly explain the process involved in Green house effect.

(30 marks)

2. a. (i) What is the role of ozone in the stratosphere?
(ii) How does it behave in the troposphere?
(iii) Write equations for the
i. produce and
ii. remove
stratospheric Ozone.

(40 marks)

b.(i) Give the property of CFCs which led to their original widespread use and now leads to their long-term presence in the stratosphere.

(ii) Show by means of equations, the ways in which CFCs lead to the loss of ozone in the stratosphere.

(iii) What are the types of chemical now being used as replacement compound for CFCs?

(iv) Explain, chemically why they do not have such a detrimental effect upon the ozone layer in the stratosphere?

(30 marks)

c. The following data given below the C-X bond energies for a series of molecules CF_3X, where X is Cl,Br and I.

X	Bond energies ($kJmol^{-1}$)
Cl	360
Br	295
I	224

(i) Calculate the maximum wavelength (in nm) of light capable of photolysing each of the above mentioned bonds

(ii) Based on the calculation in (i), explain why iodofluorocarbons pose no hazard to stratospheric ozone.
(Planck's constant, $h = 6.626 \times 10^{-34}$ Js: Speed of light, $c = 3 \times 10^{8}$ ms^{-1}: Avogadro's number, $N_A = 6.023 \times 10^{23}$ mol^{-1}).

(30 marks)

3 a (i) What is photochemical smog?

(ii) Give the conditions necessary for its formation.

(iv) Show the formation of photochemical smog by means of equations only.

(iv) Explain the harmful effects of PAN, aldehydes and O_3 in the smoggy environment

(40 marks)

b. (i) Distinguish between primary and secondary atmospheric pollutants.

(ii) Classify the following pollutants as primary and secondary pollutants CO, CO_2, SO_2, NO,O_3, HCHO and PAH compounds.

(30 marks)

c. (i) Name three importance sources of CH_4 in the stratosphere.

(ii) What is the major sink of CH_4 in the stratosphere?

(iii) What is the environment consequence of increased levels of methane in the atmosphere?

(30 marks)

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B.Sc. Degree Programme 2009/2010
Environmental Chemistry – CHU 3122

Answer Guide to Assignment I Test

1 a. (i) A **pollutant** is a substance present in greater than natural concentration because of human activity and having a net detrimental effect upon its environment or upon something a value in that environment.

Receptor is anything that is affected by the pollutant

Geosphere or solid Earth is that part of the Earth upon which humans live and from which they extract most of their food, minerals and fuels.

Source: Origin of a substance/ pollutant in the reservoir.

b (i) Acid rain
Burning of fossil fuel, an eruption of volcanoes etc emit oxides of carbon, sulphur and nitrogen into the atmosphere. These oxides react with water vapour in the air and form carbonic acid, sulphuric acid and nitric acid. These acids cause acid rain.

(ii) $2SO_2(g) + O_2(g) \rightarrow 2SO_3$
$SO_3(g) + H_2O(l) \rightarrow H_2SO_4$

$NO_2(g) + OH^- \rightarrow HNO_3(l)$

(iii) Fish: Natural aluminum compounds have very low solubility in water. thus when the pH of a lake drops from 6.0 to 5.0, Al^{3+} ion concentration in the lake increase. When fish are exposed to a high concentration of Al^{3+} ions a thick mucus forms on their gills and the fish literally suffocate. Additionally , Al^{3+} ions react with water molecules to generate , H^+ ions, increasing the acidity which brings more , Al^{3+} ions into solution to further exacerbate the problem.

Trees : Acidic water is dangerous to plants. It decolourizes the leaf pigments, making chlorophyll less.This result in decrease in agricultural productivity.

Damage to building material

Metallic surfaces exposed to acid rain are susceptible to corrosion damage.

Building materials such as limestone, marble etc are weakened on reaction with acidic waters.

c. (i) CH4, N2O, NO, NO_2 , SO_2, Rn. Xe. $CF2Cl_2$. CF_3Cl,

(ii) Nitric oxide (NO), NO_2

(iii Rn

(d) (i) Green house gases in an atmosphere that absorb and emit radiation within the thermal infrared range. E.g CO_2, H_2O and CH_4.

(ii) Of the energy which enters the Earth atmosphere 47% reaches the Earth's surface. Incoming energy from the Sun is in the UV, visible and infrared regions of the electromagnetic spectrum. Because the surface of the Earth is at a much lower temperature than the Sun, the radiation re- emitted from the Earth is of lower energy, and is in the infrared region. Some of the infrared radiation is absorbed by water vapour and carbon dioxide in the air and then re-emitted to the Earth. The average temperature of the Earth's surface is maintained at 14°C by the portion of this re-emitted radiation which is returned to Earth.

2. (a) (i) The ozone in stratosphere absorbs ultraviolet radiation with wavelength in the range 230nm-340 nm which prevents most of the radiation of wavelengths less than 340 nm from reaching the Earth. In this way, plants and animals are protected.

(ii) Ozone present in the troposphere (low level ozone) is a dangerous pollutant. Depending on concentration it can have a serious effect on human health, on vegetation and on synthetic polymers.

(.ii) Production

$O_2 + h\upsilon \rightarrow O+O^*$

$M+ O_2 +O^* \rightarrow O_3+ M^*$

Removal

$O_3 + h\upsilon \rightarrow O_2+O^*$

$O_3 + O^* \rightarrow 2O_2$

$NO^{\cdot} + O_3 \rightarrow NO_2 + O_2$

$O_3 + OH^{\cdot} \rightarrow O_2 + HOO^{\cdot}$

b. (i) Lack of reactivity
Low flammability
Low toxicity

(ii) $CCl_2F_2 + h\upsilon \rightarrow Cl^{\cdot} + CClF_2$ or $CCl_3F + h\upsilon \rightarrow Cl^{\cdot}$

$Cl^{\cdot} + O_3 \rightarrow ClO + O_2$

$ClO^{\cdot} + O \rightarrow Cl^{\cdot} + O2^{+}$ (atomoic oxygen from stratosphere)

The net react on is $Cl^{\cdot} + O_3 \rightarrow ClO^{\cdot} + O_2$

$ClO^{\cdot} + O \rightarrow Cl^{\cdot} + O_2^{+}$

$O_3 + O \rightarrow 2O_2$ is destruction of O_3

In this region, NO is also present. So

$ClO^{\cdot} + NO \rightarrow Cl + NO_2$

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + NO \rightarrow Cl^{\cdot} + NO_2$

$O_3 + NO \rightarrow O_2 + NO_2$

(iv) Hydrofluorocarbons and hydrochlorofluorocarbons

(v) Hydrochlorofluorocarbons contain C - H bonds which are broken down in the troposphere. This initiates breakdown of the entire molecule and the chlorine is thus unable to reach the stratosphere.

c.(i) For C-Cl bond, wave length 332 nm
For C- Br bond, wave length 405 nm
For C-I bond, wave length 534 nm

(ii) Longer wave length. It is needed less energy. So it will dissociate in the troposphere. so it will not go to stratosphere. Hence No harzard.

3.a (i) It is an air pollution produced by the action of sun light on hydrocarbon, nitrogen oxides and other pollutants.

(ii) The condition for the formation of photochemical smog are

- High concentration of hydrocarbons and nitroxides(NO_x)
- Sun light
- Temperature above 18^0C

(iii)PAN- reduces visibility
eye irritant
Aldehyde- drowsiness
eye irritant
O_3 – eye irritant
Cracks and ages rubber
wheezing, bronchial construction and irritation to respiratory mucous system

(iv) Formation of NO_2

In combustion engine chamber

$$N_{2(g)} + O_{2(g)} \rightarrow 2\,NO_{(g)}$$

$$2NO_{(g)} + O_{2\,(g)} \rightarrow 2\,NO_{2\,(g)}$$

Formation of O_3

$$NO_2 + h\upsilon \rightarrow NO + O$$

$$O_2 + O \rightarrow O_3$$

$$NO + O_3 \rightarrow NO_2 + O_2$$

Formation of hydrocarbon radicals

$$RCH_3 + OH \cdot \rightarrow RCH_2\cdot + H_2O$$

Formation of peroxyl radicals

$$RCH_2\cdot + O_2 \rightarrow RCH_2O_2\cdot$$

$$RCH_2O_2\cdot + NO \rightarrow RCH_2O + NO_2$$

Product on of aldehydes

$$RCH_2O + O_2 \rightarrow RCHO + HO_2\cdot$$

Production of peroxyl compounds

$$CH_3CO + O_2 \rightarrow CH3COO\cdot$$

$$CH3CCO\cdot + NO_2 \rightarrow CH_3COONO_2\ (PAN)$$

b. (i) Primary pollutant are those that are emitted directly from the source.
Secondary pollutant are those that are produced by reactions in the open atmosphere.

(i) Primary pollutant – CO, CO_2, SO_2, PAH
Secondary pollutants – O_3, HCHO, NO_2, NO

c. (i) Sources of sink – natural gas
Refining of petroleum
Decaying vegetable matter
Anaerobic degradation

(ii) major sir k for CH_4 – hydroxyl radical
soil

(iii) Environment consequences of increased levels of CH_4 - global warming
It is estimated that methane is 30 times more effective than CO_2 in its IR trapping characteristics. Therefore when CH_4 concentration in atmospheric temperature will be increased.-Global effect

So effect - I Temperature extremes
melting of polar caps
sea level rise, whether pattern affected, Desertification