The Open University of Sri Lanka

B.Sc. Degree Programme 2011/2012

CMU 3129 - Level 5

Environmental Chemistry

Assignment 11 Test

Date: 22.04.2012 (Sunday) **Time: 4.00 p.m. – 5.30 p.m.**

Reg. Number ..... **Staff's signature** .....

Answer all the questions

1. a. i. What do you mean by the term 'productivity' of water body?

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ii. Briefly explain how it is related to a water body.

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iii. Write down the **three** main physical properties of a water body that affect aquatic life

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(40 marks)

b. i. What is meant by the term 'Eutrophication'.

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ii. Give three undesirable effects of eutrophication?

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(20 marks)

c. i. Write the importance of dissolved oxygen in water bodies.

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ii. What do you understand by eutrophic lake?

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iii. Draw the dissolved oxygen profile in an eutrophic lake

(40 marks)

2. a. i. State Henry's Law.

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ii. The concentration of O_2 in water at equilibrium with pure gaseous O_2 at a pressure 1.0 atmosphere is 1.3×10^{-3} mol dm^{-3} at 25° C. What is the concentration of dissolved oxygen in water at equilibrium with air at the same temperature?

(Partial pressure of O_2 = 0.21 atmosphere)

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(30 marks)

b. i. Define the term 'Total alkalinity'.

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ii. Give three major species that are responsible for the alkalinity in water.

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iii. Calculate the alkalinity of a water sample if 8.62 cm^3 of 4.60×10^{-3} mol dm^{-3} HCl are needed to titrate a 500 cm^3 sample to a methyl orange end point.

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(30 marks)

c. i. What is hard water?

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ii. Briefly describe the chemical difference between permanent hardness and temporary hardness in water.

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iii. What do you mean by the term 'Biochemical Oxygen Demand' (BOD)?

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iv. Why do you get a higher Chemical Oxygen Demand (COD) than BOD for the same water sample?

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(40 marks)

3.a. i. Define the term pE

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ii. How does pE vary with depth in a stratified lake? Explain.

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iii. What are the uses of pE –pH diagrams?

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Consider the following equilibrium reaction.

$$NO_3^- + H^+ \leftrightarrow NH_4^+ + H_2O$$

iv. Write the above redox reaction in terms of one electron – mole.

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v. Write a relationship of pE to pE^o for the above redox reaction.

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vi. Given that pE^o value for the above redox reaction as 14.90. What will be the pE value when $[NH_4^+] = [NO_3^-]$ at pH 7.00?

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(70 marks)

b. i. What are two the reasons that soap is environmentally less harmful than ABS surfactant used in detergent?

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ii. What are disadvantages in the use of soaps?

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iii. Discuss how do surfactants from detergents affect water treatment process?

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(30 marks)

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CMU 3129 - Level 5 - Environmental Chemistry
Assignment Test II – Answer Guide

Q1 a. i) Refer Page 10

ii) Low Productivity – For water supply & swimming
High Productivity – Gives support for fish
Excessive Productivity – Growth of algae life.The concurrent decomposition of dead algae reduces oxygen level. There can be chocking by weeds & odour problems or Eutrophication

iii) Temperature, Transparency, Turbulence (Page 11)

b. i) The increase in the concentration of nutrients in a water body.

ii) Refer Page 12

c. i) For respiration
For decomposition of organic matters.

ii) Eutrophilic lakes have *more nutrients, high productivity*, i.e. support more life & are turbid.

iii) Refer Page 19 - Fig 2.1

Q2 a. i) Henry's law states that, Solubility of a gas in a liquid is proportional to the partial pressure of that gas.

ii) From Henry's law $[O_2]_{aq} = K_H . P_g$
At PO_2 = 1.0 atm $K_H = \underline{1.3\times10^{-3} \text{ mol dm}^{-3} / 1.0 \text{ atm}}$
At PO_2 = 0.21atm Since the temperature constant K_H will be same
Hence $[O_2]_{aq} = \{1.3\times10^{-3} \text{ mol dm}^{-3} / 1.0 \text{ atm}\} \times 0.21\text{atm} = \underline{2.73\times10^{-4} \text{ mol dm}^{-3}}$

b. i) Refer Page 34 – Alkalinity of a water sample is a measure of its *capacity to neutralize acids*; Total alkalinity is what we measure by titrating the sample against acid using *methyl orange* as the indicator.

ii) HCO_3^-, CO_3^{2-}, OH^-

iii) No. of moles of HCl = 4.6×10^{-3} mol x 8.62 cm^3 /1000 cm^3 = $\underline{3.96\times10^{-5} \text{ mol}}$
Alkalinity = 3.96×10^{-5} mol x.1000 cm^3 /500 cm^3 = $\underline{7.92\times10^{-5} \text{ mol dm}^{-3}}$

c. i) Water that contains hardness ions; i.e. Mg^{2+} & Ca^{2+} or
Water that forms insoluble salts with soap.

ii) Permanent Hardness is due to dissolved salts of *chlorides & sulphates* of Mg^{2+} & Ca^{2+} where as temporary hardness is due to dissolved salts of *bicarbonates* of Mg^{2+} & Ca^{2+}.

iii) The amount of oxygen necessary to *decompose organic matters by microorganism in a unit volume of water.*

iv) More substance can be chemically oxidized that biologically. BOD_5 value does not represent the total BOD. (pages 23,24 }

Q3. a. i) pE = -log [a_{e^-}] or negative logarithm of electron activity.

ii) At the surface water DO is high. Therefore the epilimnion is aerobic – high pE.
At the bottom of the water body (hypolimnion) dissolved Oxygen level is low and anaerobic.
Therefore the pE decreases with the depth of the lake.

iii) It shows the *region of stability* & the *boundary limits* for various species in water.

iv) $1/8\ NO_3^- + 5/4\ H^+ + e \leftrightarrow 1/8\ NH_4^+ + 3/8\ H_2O$

v) $pE = pE^0 + 1/n \log \{[NO_3^-]^{1/8} [H^+]^{5/4} / [NH_4^+]^{1/8}\}$

vi) $pE = pE^0 + 1/n \log \{[NO_3^-]^{1/8} [H^+]^{5/4} / [NH_4^+]^{1/8}\}$
n=1 $= 14.90 + \log 1 + 5/4 \log [H^+]$
$= 14.90 + \log 1 - 5/4\ pH$
pH = 7 $= \underline{6.15}$

b. i) As soon as soaps gets in to sewage or an aquatic system, it is generally *precipitated as Ca & Mg salts*. It under goes *microbial biodegradation*. So, eliminated from the environmental.

ii) The Mg^{2+} & Ca^{2+} *ion can produce insoluble fatty acid* salts.
There insoluble *Ca & Mg salts produce grey deposits on the cloths*. Also a large amount of soap is *lost* in this way.

iii) Refer Page 08