The Open University of Sri Lanka

B.Sc. Degree Programme

Environmental Chemistry- CMU 3129 – Level 5

Continuous Assessment Test II (NBT) -2013/14

Duration: One hour

Date: 09.04.2014 (Wednesday) **Time: 8.45 am – 9.45 am**

Reg. No. ..... **Invigilator's Signature** .....

Question No.	Marks
1.	
2.	
Total	
%	

Answer all the questions.

1.a. Lakes are generally classified into three types. Give the names of the types of lakes with their characteristics. (30 marks)

Types	Characteristics		
	Appearance	Nutrient level	Dissolved oxygen
1.			
2.			
3			

b.i. Name, state and give the mathematical expression for the law that describes the following kind of equilibrium.

$$\mathbf{X(g) \leftrightarrow X(aq)}$$

Name: .....

Law:

.....

.....

.....

.....

Mathematical expression: .....

ii. Assume that the atmosphere contains 20% O_2 and 80% N_2. The atmospheric pressure is 1.01325×10^5 Pa. How much of O_2 would dissolve in one dm^3 water? The equilibrium constant for $\mathbf{O_2(g) \leftrightarrow O_2(aq)}$ is 1.3×10^{-8} mol dm^{-3} Pa^{-1}.

.....

.....

.....

.....

.....

(30 marks)

c. i. Define the term "Chemical Oxygen Demand" (COD).

.....

.....

.....

ii. Briefly explain how you would determine COD of a water sample.

.....

.....

.....

.....

.....

.....

.....

.....

iii. What general groups of organic compound are not oxidized in the COD test?

.....

iv. Calculate Theoretical COD (ThOD) of water sample containing 300 mg /L of a compound having molecular formula $C_{16}H_{30}O_2$. [Relative atomic mass: C=12; H=1; O=16]. (30 marks)

.....

.....

.....

.....

.....

.....

d. Give the major components of detergents and their role in cleaning process.

Component	Role
1.	
2.	

(10 marks)

2.a. i. Give **three (03)** anthropogenic chelating agents that are released into water bodies.

.....

.....

ii State major environmental problems associated with these anthropogenic chelating agents.

1.....

.....

.....

2.....

.....

.....

(20 marks)

b. i. What is hardness?

.....

ii. What are the principal hardness - causing cations?

.....

iii. A sample of ground water has 100 mg/L Ca^{2+} and 10 mg/L Mg^{2+}. Express its hardness in mg $CaCO_3$ /L. [Relative atomic mass: Ca = 20; Mg = 24; C=12; O = 16]

.....

.....

.....

.....

.....

.....

(30 marks)

c. Water is reduced under highly reducing condition as follows.

$2H_2O + 2e^- \leftrightarrow H_2(g) + 2OH^-(aq)$, For this reaction, $E^o = -0.828$ V

i. Calculate pE^{o} for the above half reaction.

.....

.....

ii. Write an expression that relates pE to pE^{o} for the above half reaction.

.....

iii. If the partial pressure of H_2 is 1 atmosphere and the pH of water is 6, calculate pE of this reaction. (30 marks)

.....

.....

.....

.....

.....

.....

c. i. What is potable water?

.....

ii. The following are the various steps involved in the process of municipal water treatment. State the function of each step in the treatment.

Step	Function
Aeration	
Chemical coagulation	
Chlorination	

(20 marks)

The Open University Of Sri Lanka

B.Sc Degree Programme – 2013/14

Environmental Chemistry – 3129 – Level 5

Answer Guide to CAT – II

1.a.

Types	Characteristics		
	Appearance	**Nutrient level**	**Dissolved Oxygen**
1.Oligotrophic	Clear	Deficient in nutrients	Water will be saturated with O_2 from top to bottom
2.Eutrophic	Turbid	High nutrients	Epilimnion is well oxygenated O_2 depleted from hypolimnion
3.Dystrophic	Colored Water with low pH (acidic)	Lower nutrient level	Poor dissolved oxygen

b. i. Refer page 16 – UNIT II – Environmental Aquatic Chemistry

ii.Calculate the mole fraction of O_2, $X_{O2} = 20/100$

Find the Partial pressure using $Po_2 = Xo_2 P$ (P is given)

Apply Henry's Law to Calculate $[O_2]_{aq}$,

$[O_2]_{aq} = K_H.Po_2$ (K_H is given)

$[O_2]_{aq.} = 2.63445 \times 10^{-4}$ moldm^{-3}

c. i. Refer Page 24 – UNIT II - Environmental Aquatic Chemistry

ii. Refer Page 24 – UNIT II

iii. Refer Page 25 – UNIT II

iv. Write the balanced equation for oxidation of $C_{16}H_{30}O_2$ by O_2

$$C_{16}H_{30}O_2 + \frac{45}{2}O_2 \rightarrow 16CO_2 + 15H_2O$$

Find the O_2 equivalent from the above equation

Refer Page 26 for the similar example.

Calculate ThOD(Refer Page 26 for similar example)

ThOD = 850mg/l

d. Refer Page 97.

2. a.(i). Anthropogenic Chelating Agents

Polyphosphates

Nitrilotriacetic acid (NTA)

Ethylene diammine tetra acetic acid (EDTA)

(ii). Phosphates : - Cause of Algal bloom – Eutrophication

NTA and EDTA - Can Solubilize toxic heavy metals from sediments

NTA - metal complexes are quite resistant to microbial degradation.

b. (i) Refer Page 39 – UNIT II – Environmental Aquatic Chemistry

(ii) Refer Page 39 – UNIT II

(iii) $[Ca^{2+}] = 100$ mg/l

Calculate $n_{Ca^{2+}} = \frac{100 mg/l}{40\times10^3 mg/mol} = 2.5\times10^{-3} mol/l$

Calculate $n_{Mg^{2+}} = \frac{10 mg/l}{25\times10^3 mg/mol} = 0.41\times10^{-3} mol/l$

You have to report the hardness as ..... mg $CaCO_3$/l

So you have to assume that,

1 mol of Mg^{2+} = 1 mol of Ca^{2+} = 1mol of $CaCO_3$

$\therefore$ Total number of $Mg^{2+} + Ca^{2+} = (2.5\times10^{-3} + 0.41\times10^{-3}) mol/l$

$= (2.5\times10^{-3} + 0.41\times10^{-3})$moles of $CaCO_3$

Weight of $CaCO_3 = 2.91\times10^{-3} mol/l \times 100 g/mol$

$= 291\times10^{-3} g/l$

Weight of CaCO3 in mg $= 291\times10^{-3}\times10^3 mg/l$

$= 291$ mg/l

$\therefore$ Hardness = 291 mg $CaCO_3$/l

c. (i) $2H_2O - 2e^- \leftrightarrow H_{2(g)} + 2OH^-$

$H_2O - e^- \leftrightarrow$ ½ H2 + OH^-

E^0 is given as -0.828V

$\therefore pE^0 = \frac{E^0}{0.0591} = \frac{0.828V}{0.0591V} = -14.0$

(ii) Expression

You can derive the expression.

$$K_{eq} = \frac{P_{H_2}^{1/2} . a_{OH^-}}{[H_2O] . a_{e^-}} \qquad [H_2O] = \text{Unity} = 1$$

$$K_{eq} = \frac{1}{2} \log P_{H_2} + \log a_{OH^-} - \log a_{e^-}$$

$$\log K_{eq} = \frac{1}{2} \log P_{H_2} + \log a_{OH^-} - \log a_{e^-} \qquad [-\log a_{e^-} = pE]$$

$$\log K_{eq} = \frac{1}{2} \log P_{H_2} + \log a_{OH^-} + pE$$

$$pE = \log Keq - \frac{1}{2} \log P_{H_2} - \log[OH^-] \qquad [\log Keq = pE^0 ; pOH = -\log[OH^-]]$$

$$pE = pE^0 - \frac{1}{2} \log P_{H_2} + pOH$$

$$[pOH = 14 - pH : pE^0 = 14; P_{H_2} = 1]$$

$$= 14 - \frac{1}{2} \log 1 + 14 - pH$$

$$pE = 14 - 14 - pH \qquad [\log 1 = 0]$$

$$pE = -pH = -6$$

- You can use the following general equation to write the expression

$$pE = pE^0 + \frac{1}{n} \log \frac{[oxidizing]^m}{[reducing]^n}$$

d. (i) Refer Page 109 – UNIT II

(ii) Refer Page 110 – UNIT II