The Open University of Sri Lanka

B.Sc. Degree Programme 2017/18

Environmental Chemistry – CYU5309

Continuous Assessment Test 1I (No Book Test)

One Hour

Date: 22.07.2018 **Time: 9.00 a.m. – 10.00 a.m.**

Answer all the questions

1.a. i. Explain why water has a high specific heat capacity and outline its biological significance.

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ii. Outline the process of eutrophication.

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iii. Evaluate the impacts of eutrophication.

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(20 marks)

b. i. Lake is a waterbody completely encapsulated by land. Compare and contrast oligotrophic lakes with eutrophic lakes.

	Oligotrophic Lakes	Eutrophic lakes
1		
2		
3		
4		
5		

ii. Oxygen is the key substances in determining the existence of life in a waterbody. Confirm by calculation the value of 8.7 ppm for the solubility of oxygen in water at 25 °C. Given that Henry's Law constant $K_H = 1.3 \times 10^{-3}$ mol L^{-1} atm^{-1} at 25 °C. Partial pressure of $O_2 = 0.21$ atm. Atomic weight of O =16 g / mol.

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(40 marks)

c. **i.** What is the alkalinity (as mg/L $CaCO_3$) of water containing 80 mg/L bicarbonate and 15 mg/L carbonate?

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(20 marks)

d. Briefly describe the environmental significance of the following substances.

i. Sodium tri phosphate (STP)

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ii. Nitrilotriacetic acid (NTA)

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(20 marks)

2.a. i. Why Nitrogenous Bio Chemical Oxygen Demand (NBOD) is insignificant in the domestic 5 – day BOD test?

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ii. A 2 mL portion of river water sample was diluted to one liter, and aerated. The dissolved oxygen content was 7.8 mg/L initially. After 5 days, the dissolved oxygen content had dropped to 5.9 mg/L. What is the BOD_5 of this sample?

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(20 marks)

b. i. What do you understand by the term pE of an aquatic system?

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ii. Calculate pE for acid mine water sample having $[Fe^{3+}] = 10^{-5}$ M and $[Fe^{2+}] = 10^{-3}$ M. Given that

$Fe^{3+} + e \rightarrow Fe^{2+} \qquad pE^o = 13.0$

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(30 marks)

c. i. Give the sources and major effects related to thermal pollution.

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(20 marks)

d. i. Distinguish between primary and secondary treatment of wastewater.

	Primary treatment	Secondary treatment
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2.		
3.		
4.		

ii. Explain the role of Poly chlorinated benzenes (PCB) in environmental pollution.

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(30 marks)

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B.Sc. Degree Programme 2017/2018
Environmental Chemistry –CYU5309
Answer Guide for Continues Assessment Test 2 (No Book Test)

1. (a) (i) Water's high specific heat capacity is caused by hydrogen bonding among water molecules. Because of it, relatively large amount of heat is required to change the temperature of a mass of water, it has stabilizing effect upon the temperature of nearby geographic regions. This property prevent sudden changes of temperature in large bodies of water, it therefore protects aquatic organisms from shock of abrupt temperature variations.

(ii) - Water body receives too much of nitrogen and phosphorus.
- Algal blooms occur due to increased nutrients.
- Increased grouth of phytoplankton and algae cut off light to submerged plants.
- Decomposition of plant material and build up of bacterial population.
- Oxygen content in the water body fall significantly. i.e. BOD is increasing.
- It becomes anoxic and unable to support life.

(iii) - Loss of water bodies.
- Loss of biodiversity.
- Health effects from drinking nitrate-rich water.
- Economic losses to farmers due to loss of fertilizers from soil.

(b) (i)

	Oligotrophic Lakes	Eutrophic Lakes
1	Lakes are with low nutrients	Lakes with high nutrients
2	Clear water	Blackish water /turbid
3	Cold water	Warm water
4	Limited supply of nutrients and low capacities to support a food web.	High capacity to support life
5	High dissolved oxygen and low BOD	Low dissolved oxygen and high BOD at the bottom of the lake

(ii) $[O_2]_{aq} = K_H \cdot P_{O2}$
$[O_2]_{aq} = 1.3 \times 10^{-3}$ mol L^{-1} $atm^{-1} \times 0.21$ atm
$= 2.73 \times 10^{-4}$ mol. L^{-1}
$= 2.73 \times 10^{-4}$ mol. $L^{-1} \times 32$ g mol^{-1}
$= 87.36 \times 10^{-4}$ g L^{-1}
$= 87.36 \times 10^{-4} \times 10^{-3}$ mg/ L
$= 8.74$ ppm

(C) [Atomic weight (g /mol): Ca = 20, C = 12, O = 16, H = 1]
Find out the equivalents of HCO_3^-, CO_3^-, and $CaCO_3^{2-}$
Equivalent = Molecular weight / Charge/Valency

$[HCO_3^-] = \frac{61}{1} = 61$ g / equivalent or 61 mg /meq

$[CO_3^{2-}] = \frac{60}{2} = 30$ g / equivalent or 30 mg/ meq

$[CaCO_3^{2-}] = \frac{100}{2} = 50$ g /equivalent or 50 mg /meq

Change as mg $CaCO_3^{2-}$ /L .

$[HCO_3^-]$ = Species which is going to be changed x Equivalent weight of $CaCO_3$
Equivalent weight of that species

$[HCO_3^-]$ = 80 mg/L x 50 mg/meq = 65.5 mg $CaCO_3$ /L
61 mg/meq

$[CO_3^{2-}]$ = 15 mg/L x 50 mg /meq = 25 mg $CaCO_3$ /L
30 mg /meq

Alkalinity = (65.5 +25) mg $CaCO_3$ /L
= 90.5 mg $CaCO_3$ /L

(d) (i) Sodium tri phosphate (STP)

STP is a builder. It is added to react with magnesium and calcium ions and to prevent Ca^{2+} and Mg^{2+} forming precipitates with soaps.
It may cause eutrophication.

(ii) Nitrilotriacetic acid (NTA)

NTA is a synthetic builder which do not break down biologically. Free NTA solubilizes the toxic metals from sediments. (By making complexes)
NTA- metal complexes are resistant to microbial degradation.

2. (a) (i) Oxidation of nitrogen compounds also contributes to the BOD.Bacteria is converting ammonia to NO_2^- and NO_3^- .The population of nitrifying bacteria in domestic waste water is generally low and their reproductive rate is slow at the temperature of BOD test (20^0C).Since it takes8-10 days for the population of nitrifying bacteria to reach significant numbers. The contribution of nitrification to the 5 –days BOD is insignificant.

(ii) BOD_5 = Initial DO – Final DO
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= (7.8 -5.9) mg /L
2/100

= 1.9 mg/ L x100
2

= 950 mg/L

(b) (i) pE = -log a_e

or

pE is an hypothetical parameter which can be used to describe the oxidation or or reduction ability of water body .

(ii) $K_{eq} = \frac{[Fe^{2+}]}{[Fe^{3+}].\ a_e}$

$\log K_{eq} = \log \frac{[Fe^{2+}]}{[Fe^{3+}].} + \log \frac{1}{a_e}$

$\log \frac{1}{a_e} = \log K_{eq} + \log [Fe^{3+}] - \log [Fe^{2+}]$

$pE = \log K_{eq} + \log [Fe^{3+}] - \log [Fe^{2+}]$

$pE = pE^0 + \log [Fe^{3+}] - \log [Fe^{2+}]$

$pE = 13.0 + \log (10^{-5}) - \log (10^{-3})$

$= 13 + (-5) - (-3)$

$= 13-5+3$

$= 11$

Or

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

$$= 13.0 + \log \frac{[10^{-5}]}{[10^{-3}]} \quad \textbf{or} \quad 13.0 + \log [10^{-5}] - \log [10^{-3}]$$

$$= 13.0 + (-5) - (-3)$$

$$= 13\text{-}5\text{+}3$$

$$= 11$$

(C) Sources- Heat effluents, nuclear plants, Coal-fired power plants, hydroelectric power

Major effects – Reduction of dissolved oxygen / Change in water pollution/ Increase in toxicity/Increase in biological activities

(d) (i)

	Primary Treatment	**Secondary Treatment**
1	It is a physical method	It is a biological method
2	It removes large particles and floating materials	It removes the fine suspended and dissolved organic matter
3	Sedimentation and filtration processes are involved	Aerobic and anaerobic processes are involved
4	It is relatively simple and less time consuming process	It is relatively complex and takes a long time for its completion

(ii) PCBs are extremely stable to heat, chemicals and biological decomposition. Therefore they persist in the environment for long time. They are lipophilic and undergo bioaccumulation and bio magnification. Since they resist to biodegradation, therefore absorbed by the soil and colloidal materials in water.