University Of Technology
Building and Construction Eng. Dept.
Final Exam-First Attempt–2014/2015

Branch :Sanitary & Environ. Eng. **Class: Third**
subject : Chemistry& Microbiology **Time : 3 Hours**
Examiner : Dr.Aumar ALnakeeb **Date : 13/6/2015**
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Answer Four questions only

Q1:-A/ Wastewater is diluted by factor 1/8 using seeded control water. DO levels in the sample and control bottles are shown in table below. Determine BOD_5 value if one milliliter of seed material is added directly to diluted sample and two milliliter to control bottles.

Time (day)	Dissolved oxygen, mg/L	
	(1*ml*) Diluted sample	(2*ml*) Seeded Control
0	5.94	7.03
1	5.65	6.33
2	5.36	6.12
3	5.12	6.01
4	4.63	5.90
5	4.42	5.78
6	4.13	5.41
7	3.81	5.23

(13 marks)

B/ 1-Describe with drawing Procaryotic and Eucaryotic cells.
2-State the Factors affecting dissolved oxygen concentration in Water.
(12marks)

Q2:- A/ A 60 ml raw water samples were taken from river for BOD test by using 300 ml BOD bottles without seeding with four duplications. The initial dissolved oxygen concentrations found when taken are 6.43, 6.18, 6.84 and 6.22 mg/L respectively. After 5 days, the dissolved oxygen concentrations at 20°C incubation are 3.75, 2.83, 2.35 and 2.66 respectively. Find raw water BOD_5.

(13marks)

B/ Explain briefly of the following terms:

1- Polar Molecules and Non Polar Molecules.
2- Hardness of water.
3- The types and sources of water impurities.

(12marks)

Q3:- A/ Use Phelps law to find first – stage BOD when $t_0 = 0$ days, and Butts et al.'s equation to find first – stage BOD when $t_0 = 36$ hours according to wastewater sample data given below:

$BOD_5 = 283$ mg/L power factor = 2.0 $k_1 = 0.14\ day^{-1}$

(13marks)

B/ :- Draw a sketch showing Bacterial growth curves based on (batch and continuous culture).

(12marks)

Q4:- A/ The results of a water analysis are: calcium 40 mg/l, magnesium 10 mg/l, sodium 11.7 mg/l, potassium 7.0 mg/l, bicarbonate 110 mg/l, sulfate 67.2 mg/l, and chloride 11 mg/l. Draw a milliequivalents -per- liter bar graph and list the hypothetical combinations. Express the hardness and alkalinity in units of mg/l as $CaCO_3$.

(13 marks)

B/ Write short notes on the following terms:-

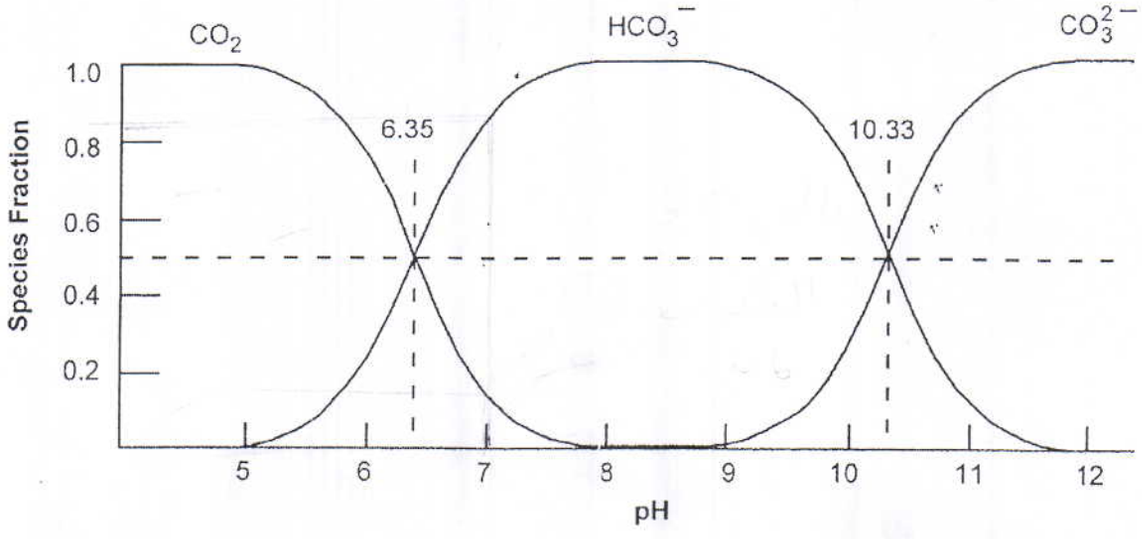
1- Phosphorus compounds.

2- pH-value.

3- Oxidation- Reduction potential.

(12marks)

Q5:-A/ Calculate the carbonate alkalinity as $CaCO_3$ of industrial water sample contains 260 mg/l of bicarbonate at pH = 7.0.



(13marks)

B/ Define the following terms:-

1-Bacteria 2- Fungi 3-Protozoa 4-Amoeba

(12marks)

Useful information:-

Atomic weights, H=1, O=16, C=12, Ca= 40, Mg= 24.4, Na= 23, K= 39.1, Cl= 35.5, S= 32

$$\frac{C}{C_o} = e^{-(Q/V)t}$$

$$C_f = \frac{Q_1C_1 + Q_2C_2}{Q_1 + Q_2}$$

$$\ln \frac{C_A}{C_{A0}} = -kt \quad or \quad \frac{C_A}{C_{A0}} = e^{-kt}$$

$$t_0 = \frac{1}{k_1} \log_{10} C$$

$$X = \frac{\Sigma(D_1 - D_2)}{n}$$

$$y = L_a[1 - 10^{-k_1 \Delta t}]$$

$$\text{BOD, mg/L} = \frac{D_1 - D_2}{P}$$

$$K_1 = k_1 \times 2.3026$$

$$\text{BOD, mg/L} = \frac{(D_i - D_e) - (B_i - B_c)f}{P}$$

$$\frac{C_3}{C_o} = \left(\frac{C_3}{C_2}\right)\left(\frac{C_2}{C_1}\right)\left(\frac{C_1}{C_0}\right) = \left(\frac{1}{1 + k_3\tau_3}\right)\left(\frac{1}{1 + k_2\tau_2}\right)\left(\frac{1}{1 + k_1\tau_1}\right)$$

$$\frac{C_3}{C_o} = \left(\frac{C_3}{C_2}\right)\left(\frac{C_2}{C_1}\right)\left(\frac{C_1}{C_0}\right) = (e^{-k_3\tau_3})(e^{-k_2\tau_2})(e^{-k_1\tau_1}) = e^{-(k_1\tau_1 + k_2\tau_2 + k_3\tau_3)}$$

$$y = L_a\left[1 - e^{-k_1(t - t_0)^m}\right]$$

حلول اسئلة الامتحان النهائي - الدور الاول
2014-2015
فرع الهندسة الطبية والبيئية المرحلة : الثالثة
المادة : كيمياء وميكروبايولوجيا الماء

Q1/A/ sol.

compute f & p

$f = \frac{1\ ml}{2\ ml} = 0.5$

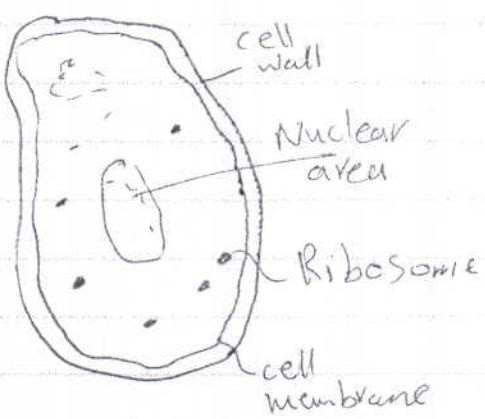
$p = \frac{1}{8} = 0.125$

$BOD_{only\ 5} = \frac{(D_i - D_e) - (B_i - B_e) f}{p}$

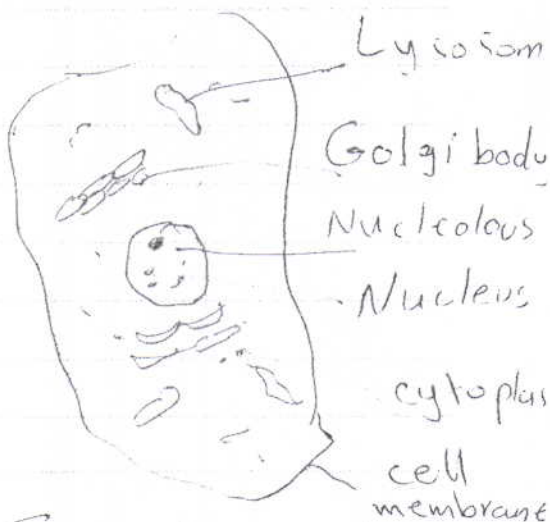
$= \frac{(5.94 - 4.42) - (7.03 - 5.78) \times 0.5}{0.125}$

$= 7.16\ mg/l$

Q1--B/ 1-

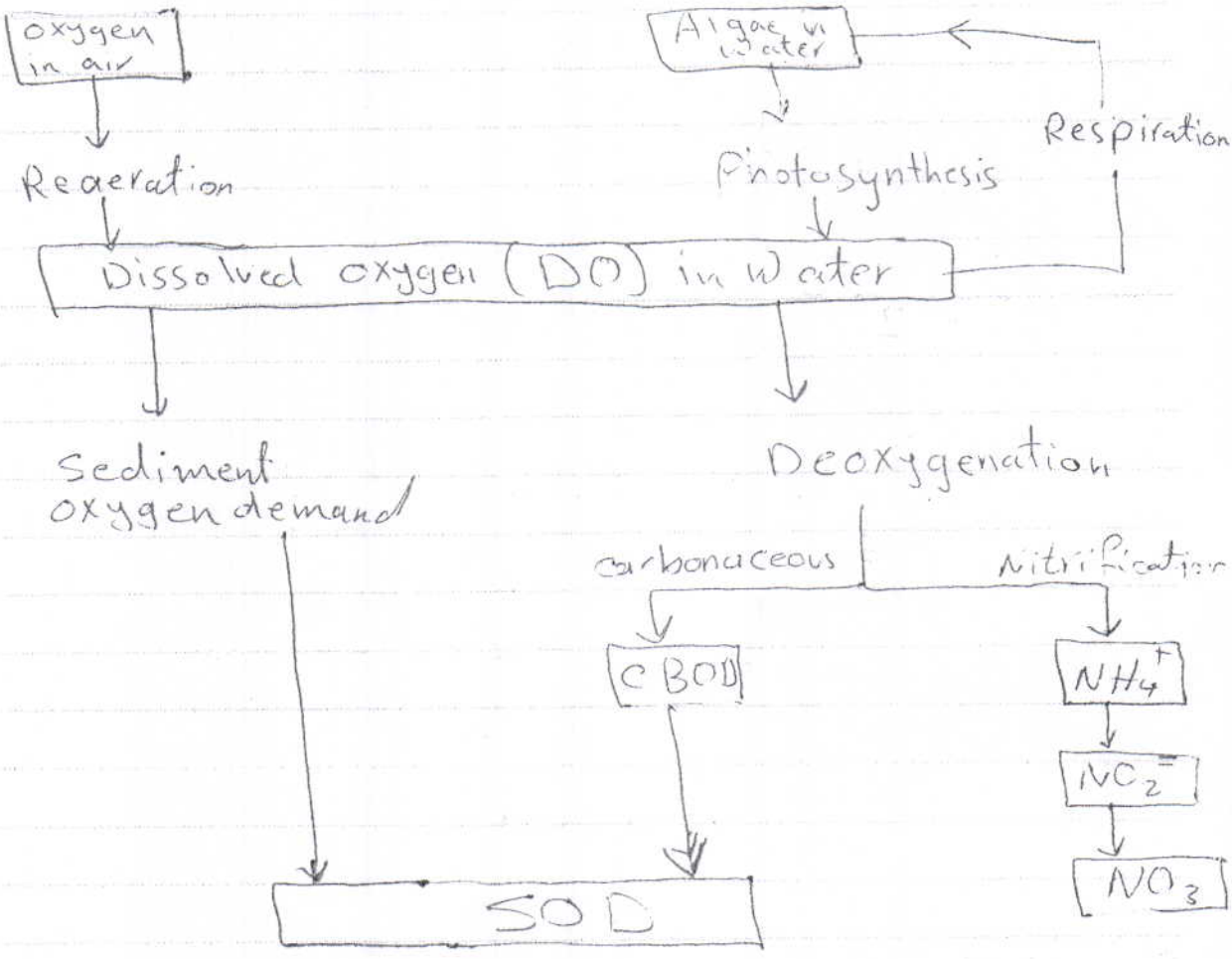


Procaryptic cell



Eucaryntic cell

Q1: B/ 2-


oxygen in air
Algae in water
Respiration
Reaeration
Photosynthesis
Dissolved oxygen (DO) in water
Sediment oxygen demand
Deoxygenation
carbonaceous
Nitrification
CBOD
NH_4^+
NO_2^-
NO_3
SOD

Q2 -- A / sol.

compute $X = \frac{\Sigma(D_1 - D_2)}{n}$

$$X = \frac{(6.43 - 3.75) + (6.18 - 2.83) + (6.84 - 2.35) + (6.22 - 2.66)}{4}$$

$$= 3.52$$

$$P = \frac{6c}{300} = 0.2$$

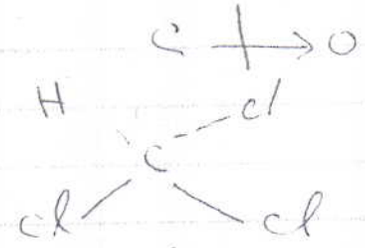
$$BOD_5 = \frac{X}{P} = \frac{3.52}{0.2} = 17.6 \text{ mg/l}$$

Q2 - B / 1 -

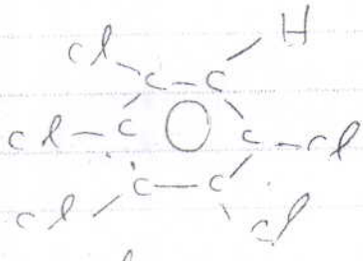
Polar Molecules

① carbon monoxide

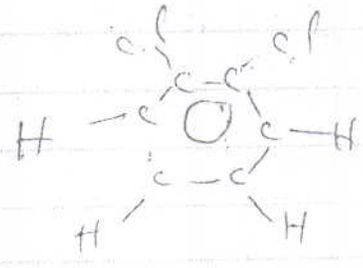
② carbon trichloride $CHCl_3$



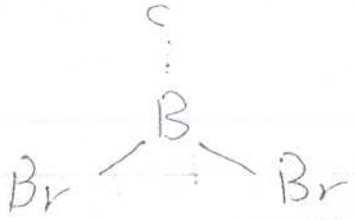
③ pentachlorobenzene



④ ortho-dichlorobenzene



(5) Boron dibromochloride



(6) Water

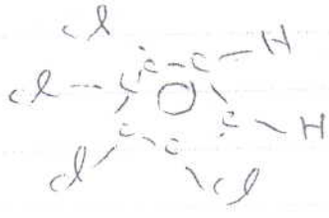
Non polar =

(1) carbon dioxide

(2) carbon tetrachloride

(3) Hexachlorobenzene

(4) para-dichlorobenzene



(5) Boron tribromide

(2) Hardness

Water hardness was a measure of the ability of water soap. It was measured by the amount of soap needed for adequate lathering and served also indicator of the rate of scale formation, hardness is a property of cations (Ca^{+2}, Mg^{+2})

Q2-B/3-

Impurities of water

- suspended
  - Bacteria
  - Algae
  - Proto Zoa
  - Viruses
  - silt, clay
  - colloids
- Dissolve
  - salts
    - cations
      - Ca^{++}
      - Mg^{++}
      - Na^{+}
      - K^{+}
    - anions
      - HCO_3^{-}
      - $CO_3^{=}$
      - $SO_4^{=}$
      - Cl^{-}
  - organics
    - color
    - odor
    - taste
    - toxcity
  - Gases
    - N_2
    - O_2
    - H_2S
    - NH_3

Q3: A/ Sol.

$t_o = 0$ days

$y = L_a (1 - 10^{-k_1 t})$

$$L_a = \frac{y}{(1 - 10^{-k_1 t})} = \frac{283}{(1 - 10^{-0.1(5)})} = 353.541 \text{ mg/l}$$

step 2 : when $t_o = 36$ hr $= 1.5$ days

$$K_1 = \frac{k_1}{0.434}$$

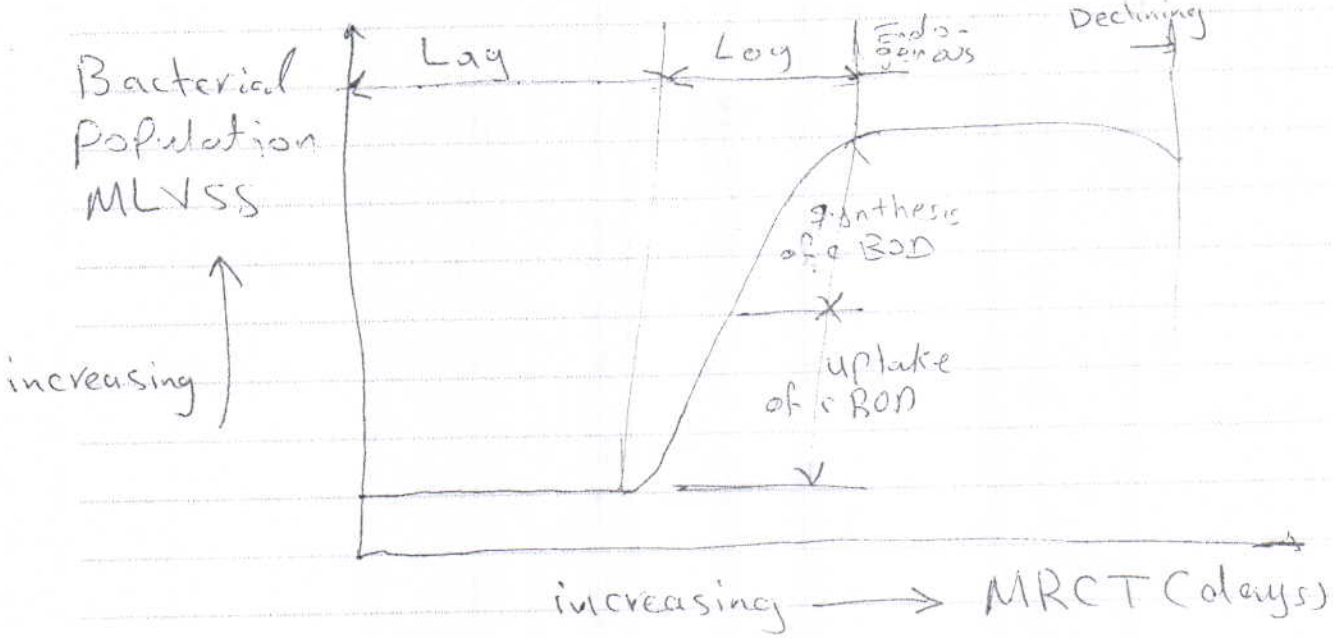
$$= \frac{0.14}{0.434}$$

$$= 0.323 \text{ d}^{-1}$$

$$L_a = \frac{y}{1 - e^{-k_1 (t - t_o)}} = \frac{283}{1 - e^{-0.323(5 - 1.5)}} = 288.518 \text{ mg/l}$$

Q3- B/

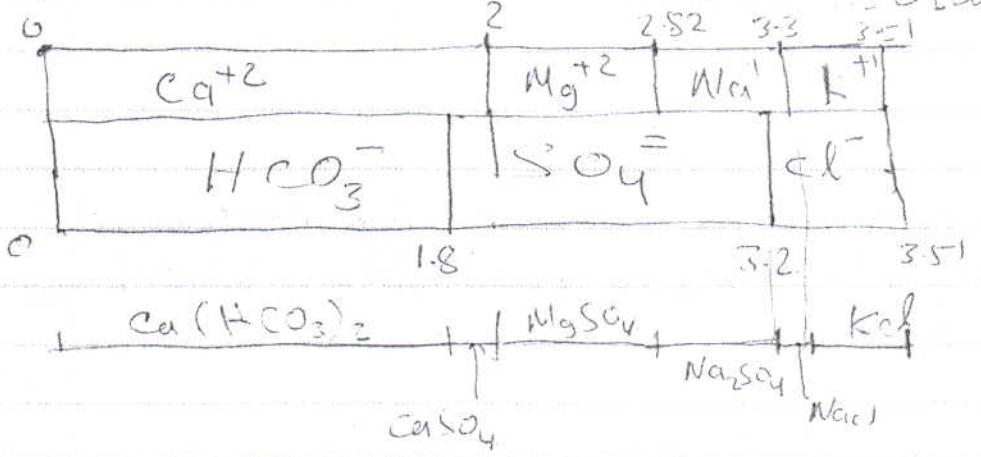
batch culture



continuous culture

Q4 = A/

component	mg/l	Eq. wt.	meq./l
Ca^{+2}	40.	20	2.0
Mg^{+2}	10	12.2	0.82
Na^{+}	11.7	23	0.51
k^{+}	7.0	39.1	0.18
		total	3.51
HCO_3^-	110	61	1.8
$SO_4^=$	67.2	48	1.4
cl^-	11	35.5	0.31
		total	3.51



$$\text{hardness} = 2.82 \text{ meq./l} * 50 \frac{\text{mg/l } CaCO_3}{\text{meq./l}}$$

$$= 141 \text{ mg/l}$$

$$\text{alkalinity} = 1.8 \times 50 = 90 \text{ mg/l}$$

Q4. B / 1-

- orthophosphates (all contain PO_4^{-3})

Trisodium phosphate – Na_3PO_4
Disodium phosphate – Na_2HPO_4
Mono Sodium phosphate – NaH_2PO_4
Diammonium phosphate – $(NH_4)_2HPO_4$

- Polyphosphates (also called condensed phosphates, meaning dehydrated).

Sodium hexametaphosphate – $Na_3(PO_4)_6$
Sodium tripolyphosphate – $Na_5P_3O_{10}$
Tetra Sodium pyrophosphate – $Na_4P_2O_7$
Organic phosphate.

2- pH is a measure of $[H^+]$, which determine the acidic or basic quality of water solution
At 25°C

pH < 7, a water solution is acidic
pH = 7, netural
pH > 7, basic

Q4- B /

3- Redox: measures the avaliability of electrons for exchange between chemical species. O_2 is an oxidizing agent in its reactions with metals and most non-metals

Q5 : A / sol.

Total carbonate $= \frac{260}{0.88} = 295.455$ mg/l

$CO_3^{=} = 0.12 * 295.455 = 35.455$ mg/l

or $= 295.455 - 260 = 35.455$ mg/l

HCO_3^- as $CaCO_3 = \frac{50}{61} = 0.820$

$CO_3^{=}$ as $CaCO_3 = \frac{50}{30} = 1.667$

Carbonate alk. (as $CaCO_3$) $= 0.820 * 260 + 1.667 * 35.455$

$= 213.2 + 59.103$

$= 272.303$ mg/l as $CaCO_3$

Q5: B/ Define

1- Bacteria : The most important organisms in biological, waste water treatment plants are the bacteria- eubacteria and archeaebacteria.

2- Fungi : are saprophytic organisms and are classified by their mode of reproduction Most fungi are free-living and include, yeast molds and mushrooms.

3- Protozoa: are unicellular organisms, are free living and solitary, but some do form colonies, are strict aerobes

4- amoeba: is a single-celled organism that moves by a pseudopodia (false-foot) mode of locomotion - that is, the streaming of cytoplasm against the cell membrane.