University Of Technology
Building and Construction Eng. Dept.
Final Exam-First Attempt–2015/2016

Branch :Sanitary & Environ. Eng. **Class: Third**
subject : Chemistry& Microbiology **Time : 3 Hours**
Examiner : Dr.Aumar AL-nakeeb **Date : 11 /6/2016**
Lec. Rana J.Kadhim

Note:- Answer Four questions only

Q1:-A/ Determine deoxygenation rate constant and ultimate BOD by Using Thomas slope method for equal time increments and BOD data at 20°C are shown in table below:

Time, (day)	0	1	2	3	4	5	6	7	8	9	10
BOD, (mg/L)	0	76.6	94.8	108.0	116.6	122.8	127.8	131.4	134.4	137.0	139.2

(13 marks)

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)

Q2:- A/ Use one day time interval, Draw the portion of remaining BOD to the ultimate BOD to reach 10 days, if you knowing that $k_1 = 0.1\ day^{-1}$.

(15marks)

B/ Fill in the blanks:-

1- If the electro negativity difference between two bonded atoms is zero, they will form a ..... covalent bond.
2- Conductivity units are .....
3- The most organisms in biological, waste water treatment plants are..... , ... and .....
4- ..... acidity measures the neutralizing effects of essentially all the acid species present in water.
5- Protozoa are placed in five groups..... , ... , ... , ... And.....

(10marks)

Q3:- A/ A ground water sample contains 300 mg/l of bicarbonate at pH= 10.33, Calculate the carbonate alkalinity as $CaCO_3$ (at pH=10.33, Total carbonate is about 50% bicarbonate ion and 50% carbonate ion).

(13 marks)

B/ 1-Describe with drawing Procaryotic and Eucaryotic cells.

2- Describe with drawing Dissolved oxygen sag curve caused by discharge of organic wastes into a river.

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

(12marks)

Q4:- A/ The soil of a refinery was contaminated by an accidental spill of gasoline . A soil sample, taken 10 days after removal of the polluting source, showed a concentration of 1200 mg/ Kg . The second sample taken at 20 days showed a drop of concentration , at 800 mg/ Kg . Assuming that a combination of all the removal mechanisms including volatilization , biodegradation , and oxidation show first-order kinetics , estimate how long it will take for the concentration to drop below 100 mg / Kg without any remediation measures taken.

(13 marks)

B/ Write short notes on the following terms:-

1- Phosphorus compounds.

2- pH-value.

3- The methods used for removing Nitrogen from waste water.

(12marks)

Q5:-A/ Calculate the hardness as $CaCO_3$ for water sample containing Calcium 50 mg /l and magnesium 60 mg /l .

(10marks)

B/ Define the following terms:-

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

(8 marks)

C/ State the Factors affecting dissolved oxygen concentration in Water.

(7marks)

Useful information:-

Atomic weights H=1, O=16, C=12, Ca= 40, Mg= 24, Na= 23, K= 39.1,

Cl= 35.5, S= 32

$$\frac{C}{C_o} = e^{-(Q/V)t} \qquad C_f = \frac{Q_1C_1 + Q_2C_2}{Q_1 + Q_2}$$

$$\ln \frac{C_A}{C_{A0}} = -kt \quad or \quad \frac{C_A}{C_{A0}} = e^{-kt} \qquad t_0 = \frac{1}{k_1}\log_{10} C$$

$$X = \frac{\Sigma(D_1 - D_2)}{n} \qquad y = L_a[1 - 10^{-k_1 \Delta t}]$$

$$\text{BOD, mg/L} = \frac{D_1 - D_2}{P} \qquad K_1 = k_1 \times 2.3026$$

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

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

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

$$DO_{ss} = 14.652 - 0.41022T + 0.0079910T^2 - 0.000077774T^3$$

$$f = \frac{2116.8 - (0.08 - 0.000115A)E}{2116.8}$$

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

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

$$\text{BOD}_5 = \frac{X}{P}$$

$$D_t = \frac{K_1L_a}{K_2 - K_1}[e^{-K_1t} - e^{-K_2t}] + D_a e^{-K_2t}$$

$$D_t = \frac{k_1L_a}{k_2 - k_1}[10^{-k_1t} - 10^{-k_2t}] + D_a 10^{-k_2t}$$

$$y = L_a(1 - e^{-K_1t})$$

$$y = L_a(1 - 10^{-k_1t})$$

$$y = L_a[1 - e^{-K_1(t-t_0)}]$$

$$y = L_a[1 - 10^{-k_1(t-t_0)}]$$

$$y = L_a[1 - e^{-K_1(t-t_0)^m}]$$

$$y = L_a[1 - e^{-K_1(t-t_0)^2}]$$

$$\frac{dy}{dt} = K_1(L_a - y) = K_1L_a - K_1y$$

$$na + b\Sigma y - \Sigma y' = 0$$

$$a\Sigma y + b\Sigma y^2 - \Sigma yy' = 0$$

$$K_1 = -b$$

$$L_a = -a/b$$

$$\frac{dy_i}{dt} = y_i' = \frac{(y_i - y_{i-1})\left(\frac{t_{i+1} - t_i}{t_i - t_{i-1}}\right) + (y_{i+1} - y_i)\left(\frac{t_i - t_{i-1}}{t_{i+1} - t_i}\right)}{t_{i+1} - t_{i-1}}$$

$$\frac{dy_i}{dt} = \frac{y_{i+1} - y_{i-1}}{2\Delta t} \quad \text{or} \quad \frac{y_{i+1} - y_{i-1}}{t_{i+1} - t_{i-1}}$$

$$K_1 = 2.3026 \times k_1$$

$$y = L[1 - 10^{-k_1(t-t_0)}]$$

$$y = L_a[1 - C10^{-k_1t}]$$

$$y_t = m\log t + b$$

$$K_{1(T)} = K_{1(20°C)} \times 1.047^{(T-20)}$$

$$k_{1(T)} = k_{1(20°C)} \times 1.047^{(T-20)}$$

$$L_{a(T)} = L_{a(20°C)}[1 + 0.02(T - 20)]$$

$$L_{a(T)} = L_{a(20°C)}(0.6 + 0.02T)$$

$$\frac{y_t}{s} = \frac{m}{s}\log t + \frac{b}{s}$$

$$\frac{y_t}{s} = M\log t + B$$

$$y_t = s(M\log t + B)$$

$$y_t = s(0.85\log t + 0.41)$$

$$y_t = S(0.85\log at + 0.41)$$

$$\frac{dy}{dt} = \frac{0.85S}{t} = K_1(L_a - y_t)$$

$$\frac{0.85S}{2.303t} = k_1(L_a - y_t)$$

$$\frac{K_{1o}}{K_{1t}} = \theta^{(T_o - T_t)}$$

حلول اسئلة الامتحان النهائي - الدور الاول العام 2015/2016

الفرع : الهندسة العمية والبيئية

المرحلة : الثالثة

المادة : كيمياء ومايكروبايولوجي الماء

Q1:- A/ Sol.

use $\frac{dy_i}{dt} = y_i' = \frac{(y_i - y_{i-1})\left(\frac{t_{i+1} - t_i}{t_i - t_{i-1}}\right) + (y_{i+1} - y_i)\left(\frac{t_i - t_{i-1}}{t_{i+1} - t_i}\right)}{t_{i+1} - t_{i-1}}$

t	y	y'	$y'y$	y^2
0	0			
1	76.6	47.4	3630.84	5867.56
2	94.8	15.7	1488.36	8987.04
3	108	10.9	1177.2	11664
4	116.6	7.4	862.84	13595.56
5	122.8	5.6	687.68	15079.84
6	127.8	4.3	549.54	16 332.84
7	131.4	3.3	433.62	17265.96
8	134.4	2.8	376.32	18063.36
9	137	2.4	328.8	18769
10	1392			
Sum	1049.4	99.8	9535.2	125625.2

determine a and b

$$na + b\sum y - \sum y' = 0$$

$$9a + 1049.4b - 99.8 = 0$$

$$a + 116.6b - 11.09 = 0 \quad \text{---} \quad (1)$$

$$a\sum y + b\sum y^2 - \sum yy' = 0$$

$$1049.4a + 125625.2b - 9535.2 = 0$$

$$a + 119.71b - 9.09 = 0 \quad \text{---} \quad (2)$$

(2) - (1)

$$3.11b + 2 = 0$$

$$b = -0.643$$

$$a + 116.6(-0.643) - 11.09 = 0$$

$$a = 86.064$$

calculate k_1 & L_a

$$k_1 = -b$$

$$= -(-0.643) = 0.643/d$$

$$L_a = -a/b = \frac{-86.064}{-0.643} = 133.85 \text{ mg/l}$$

Q1:- B/ 1- [illegible]

MEMO

Q1:- B/ Explain in details:

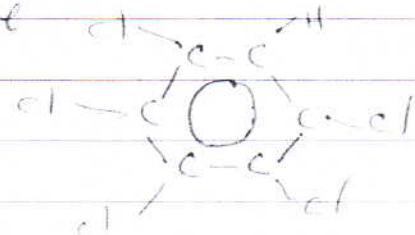
The alkalinity of water is its acid-neutralizing capacity
The acidity of water is its base-neutralizing capacity
Both parameters are related to the buffering capacity

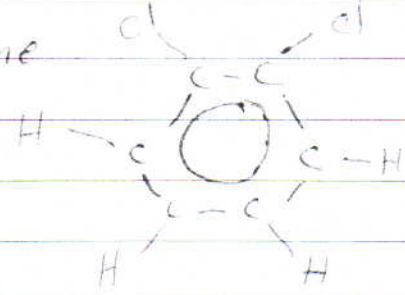
1

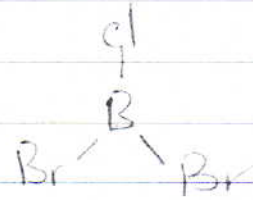
1- Polar molecules:

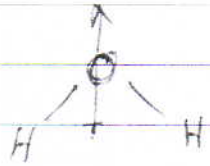
carbon monoxide 

carbon trichloride 

Pentachlorobenzene 

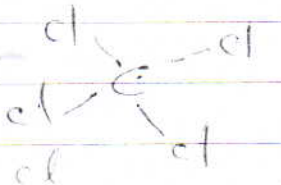
ortho-dichlorobenzene 

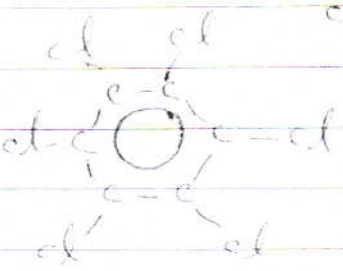
Boron dibromochloride: 

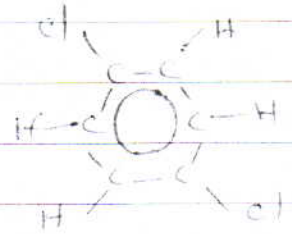
Water 

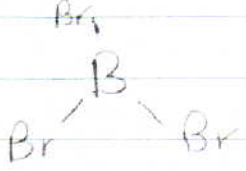
MEMO

Non-polar O=C=O carbon dioxide

carbon tetrachloride 

Hexachlorobenzene 

Para-dichlorobenzene: 

Boron tribromide 

Q1:- B/

2- Hardness of water was a measure of the ability of water to precipitate Scap. it was measured by the amount of Soap needed for adequate lathering and served as an indicater of the rate of scale formation in hot water heaters and boilers ——.

3— Source of water impurities

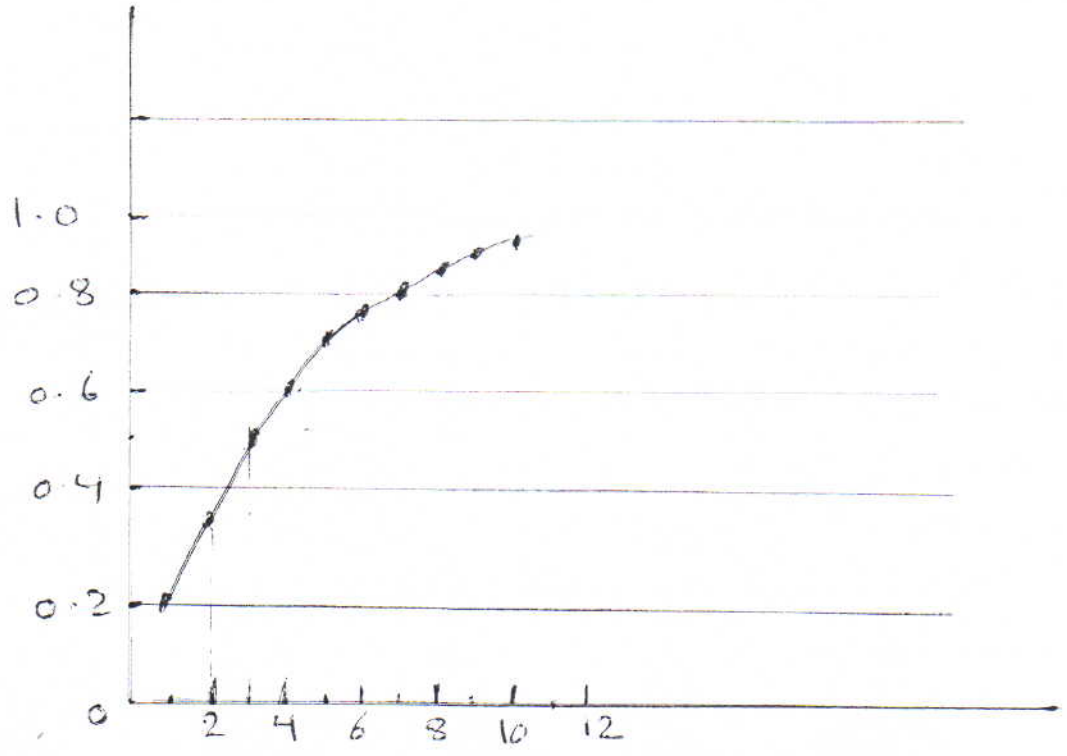
1- Unregulated impurities not considered harmful.

2- regulated impurities (pollutants) considered harmful

- Natural sources
- Human-Caused Sources

Q2 :- A / sol.

Time, day	$\frac{y}{L_a} = 1 - 10^{-k_1 t}$
1	0.21
2	0.37
3	0.5
4	0.6
5	0.68
6	0.75
7	0.8
8	0.84
9	0.87
10	0.9



Q2:- B/ Fill in the blanks:-

1- non-Polar .

2- Mmhos/cm or Msiemens/cm .

3- bacteria , eubacteria and archaebacteria .

4- phenolphthalein .

5- amoebae , Flagellate , free-swimming ciliates , crawling ciliates and stalked ciliates .

Q3:- A/ Sol.

$$\text{Total carbonate} = \frac{300}{0.5} = 600 \text{ mg/l}$$

$$CO_3^{=} = 0.5 * 600 = 300 \text{ mg/l}$$

$$\text{eq. } HCO_3 = \frac{61}{1} = 61 \quad , \quad CO_3^{=} = \frac{60}{2} = 30$$

$$CaCO_3 = \frac{100}{2} = 50$$

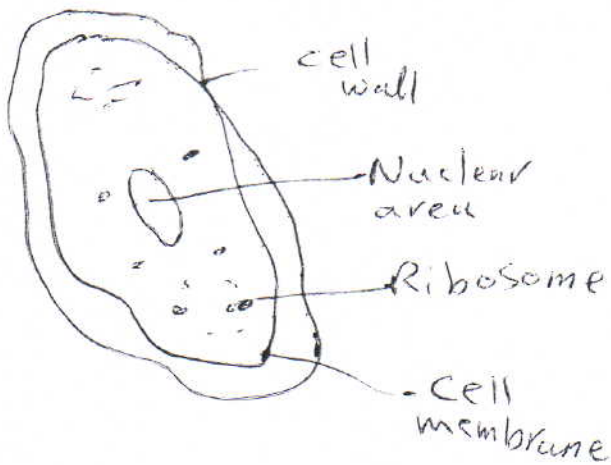
$$\frac{HCO_3}{CaCO_3} = \frac{50}{61} = 0.82 \quad , \quad \frac{CO_3}{CaCO_3} = \frac{50}{30} = 1.667$$

Carbonate alk. $= 0.82 * 300 + 1.667 * 300$

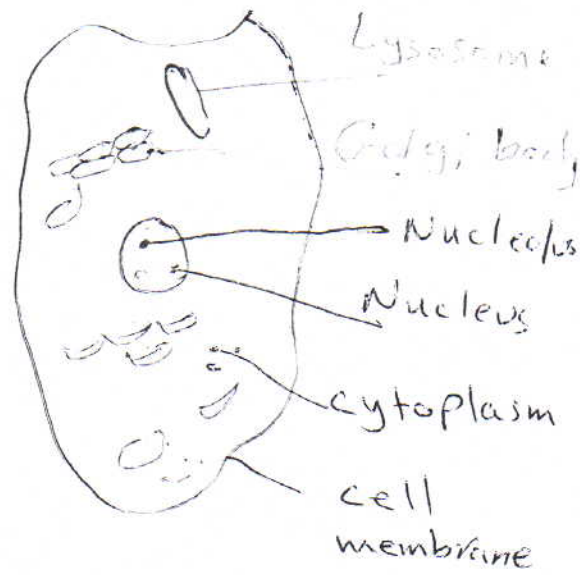
$= 246 + 500$

$= 746$ mg/l as $CaCO_3$

Q3:- B/ 1- Sol



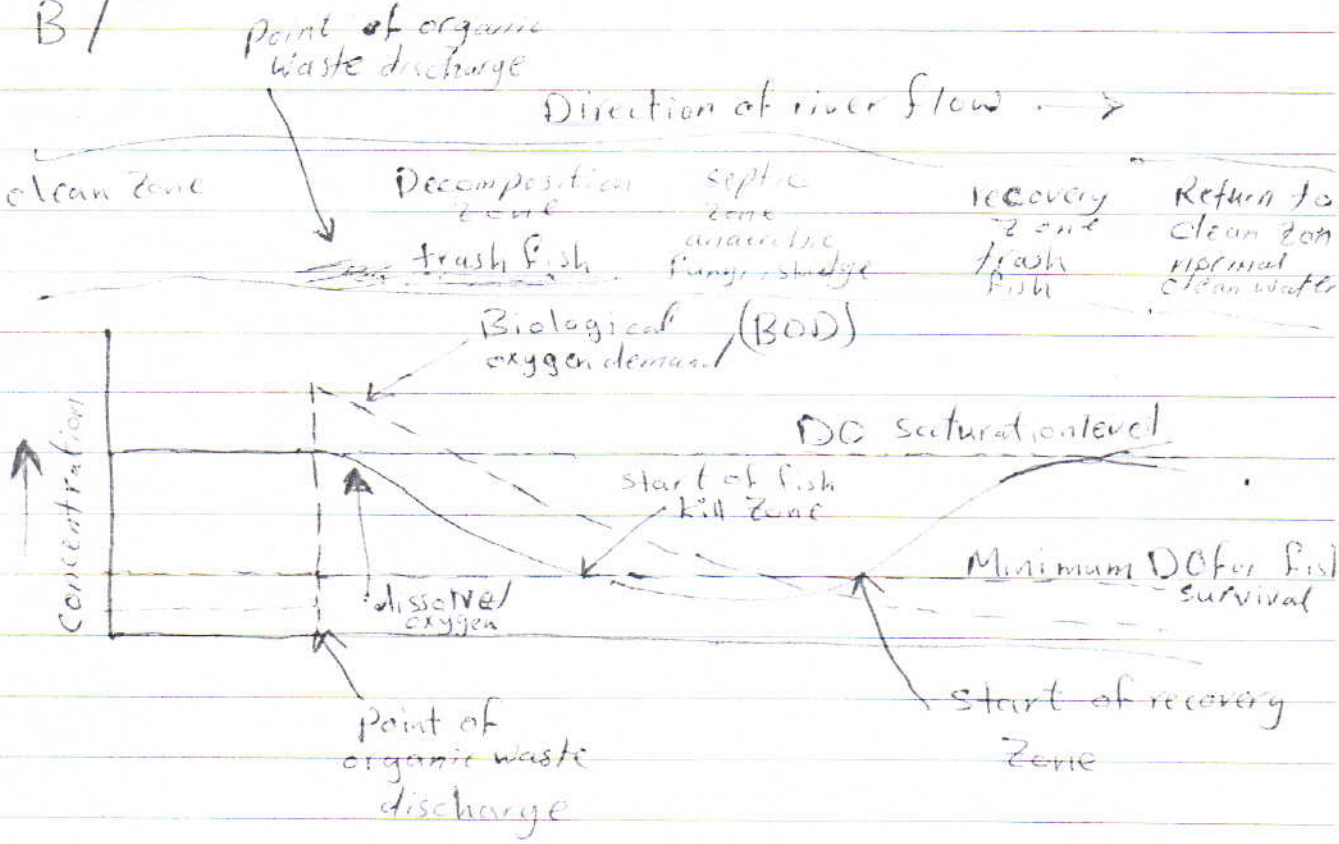
Procaryotic cell



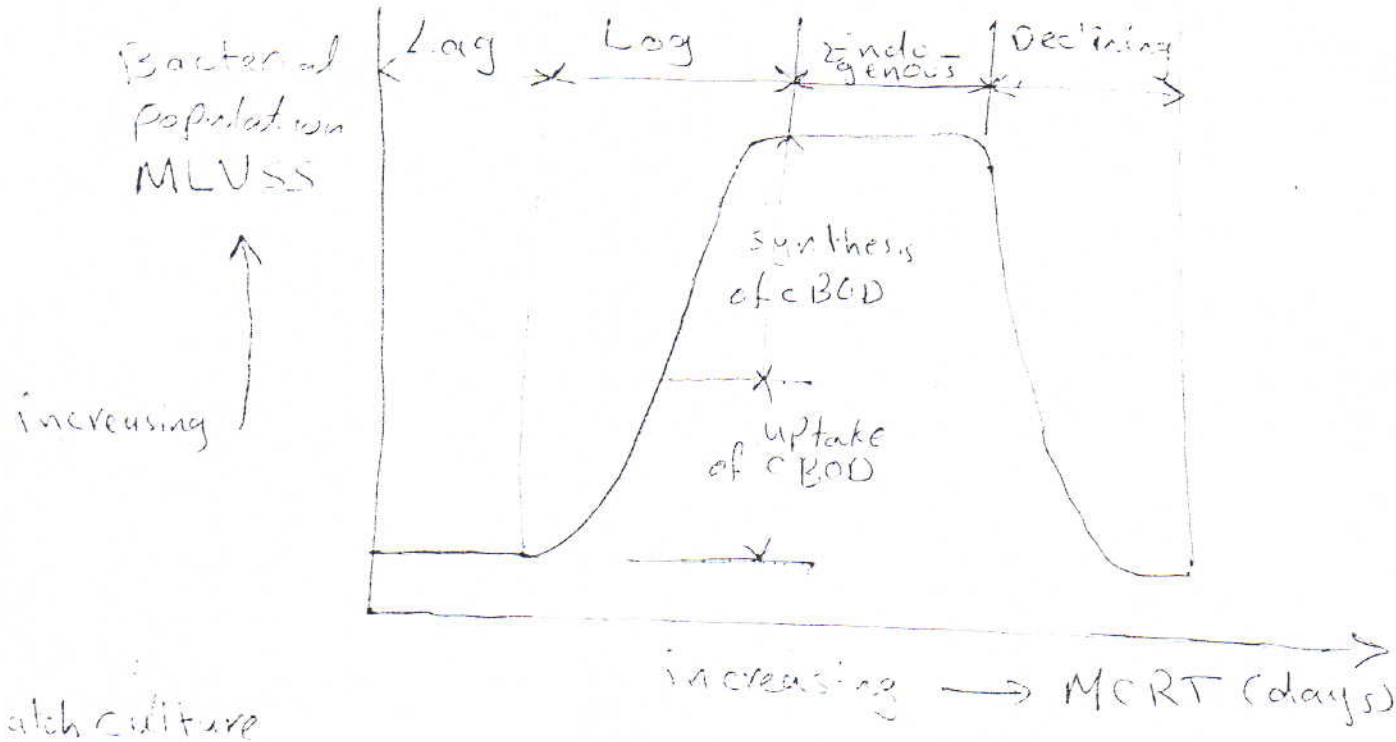
Eucaryotic cell

MEMO

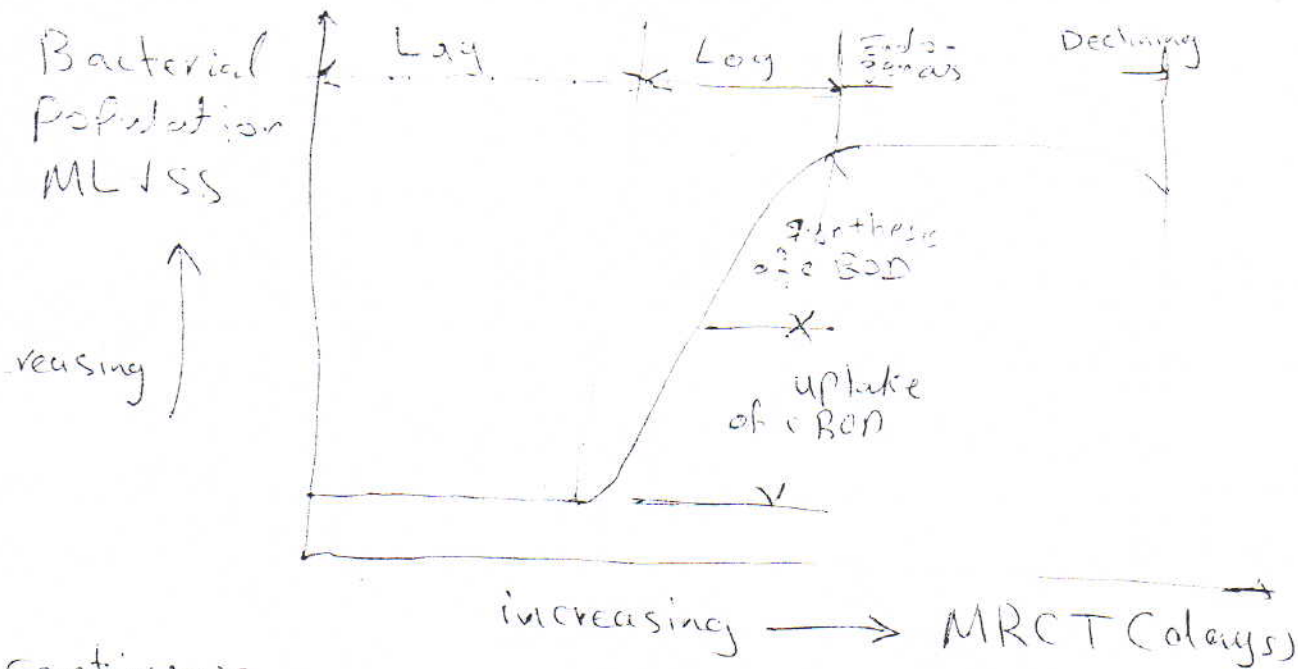
Q3/ B/ 2-


Point of organic waste discharge
Direction of river flow
clean zone
Decomposition zone
septic zone
recovery zone
Return to clean zon normal clean wate
trash fish
anaerobic fungi sludge
trash fish
Biological oxygen demand (BOD)
DO saturation level
start of fish kill zone
Minimum DO for fis survival
Concentration
dissolved oxygen
Point of organic waste discharge
start of recovery zone

Q3- B/3-



atch culture



continuous culture

Q4:-A| sol.

$$\frac{1200}{C_i} = e^{-k(10)} \quad \text{---(1) at } t = 10 \text{ days}$$

$$\frac{800}{C_i} = e^{-k(20)} \quad \text{---(2) at } t = 20 \text{ days}$$

$$\frac{1200}{800} = 1.5 = e^{10k} \div e^{20k} = e^{-10k-(-20k)} = e^{10k}$$

thus, $k = 0.027/d$

$$\frac{1200}{C_i} = e^{-(0.027)(10)} = 0.763$$

$$C_i = 1572 \text{ mg/kg}$$

For the concentration to drop below 100 mg/kg

$$\frac{100}{1572} = 0.0636 = e^{-0.027t}$$

$$t = 102 \text{ days}$$

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 solutions
At 25°C :

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

Q4:- B/ 3-

1- Air stripping Ammonia -

2- Nitrification - denitrification -

3- Break point chlorination -

4- Ammonium Ion - exchange .

5- Biosynthesis.

Q5:- A/ sol.

Total hardness as $CaCO_3$ $= 50 * 2.497 + 60 * 4.118$

$= 124.85 + 247.08$

$= 371.93$ mg/l as $CaCO_3$

Q5: B/ Define

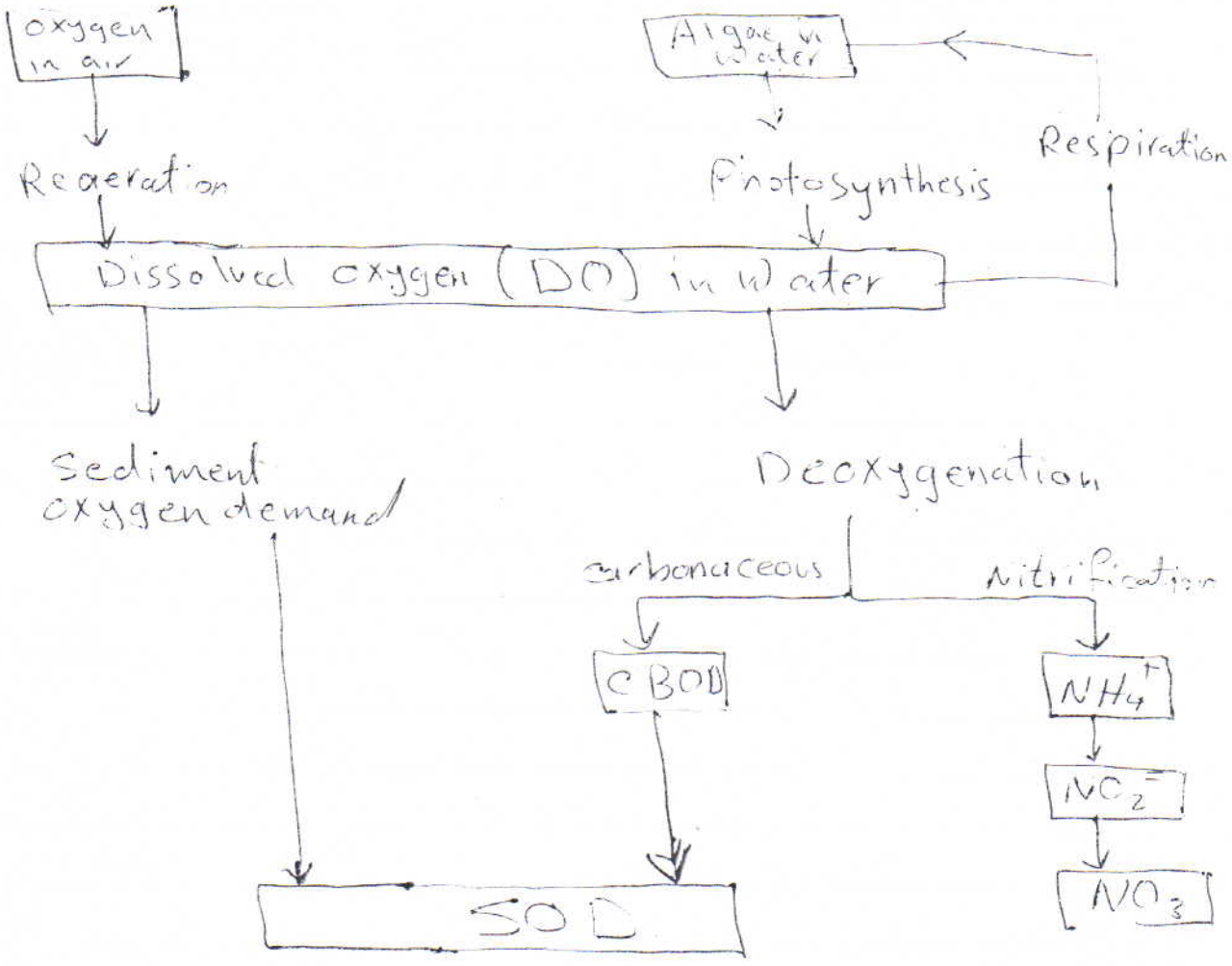
1- Bacteria - The most important organisms in biological, waste water treatment plants are the bacteria - eubacteria and archaebacteria.

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.

Q5: E/ ~~S~~ Sol


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