University Of Technology
Building and Construction Eng. Dept.
Final Exam-First Attempt–2013/2014

Branch :Structural Eng. **Class: Third**
subject : Sanitary Engineering **Time : 3 Hours**
Examiner : Lec. Rana J.Kadhim **Date : 29/5/2014**

Answer Four questions only

Q1:-A/ Compare the contact times necessary to give E. coli kills of 99.99 percent in water with free chlorine residual of 0.2 mg/l and combined chlorine residual of 1 mg/l , k values are 10^{-2} and 10^{-5} /s respectively.

(13marks)

B/ Explain in details two of the following:

1- The methods used for population forcastings.
2- The types and sources of water impurities.
3- The characteristics of sand and gravel used in filter media.

(12marks)

Q2:- A/ Determine the maximum daily consumption and fire demand in (l/c/d) for a community of 22000 capita, has an average Consumption is 600 l/c/d and fire flow dictated by a 6 story ordinary construction building of a floor area of 1000m^2/story.

(13marks)

B/ Explain briefly of the following:

1- Biochemical oxygen demand (BOD).
2- The factors that affect process of self – purification of stream.
3- Breakpoint chlorination.

(12marks)

Q3:-A/ In a rectangular sed. Tank , inlet velocity 25 cm/ min , L:W 2:1 , effluent weir length 60 m, detention time 2 hr , the smallest particle to be removed 100% is 0.06 mm in diameter , S.G.= 1.2 , ρ_w = 1 gm/ cm^3 , $\mu = 1.03 * 10^{-2}$ gm/ cm.s. find:

1- SOR (m/d).
2- Dimension of tank (m).
3- Weir loading (m^3/m/d).

(13marks)

B/ Draw a sketch showing physical and biological processes (units) of conventional waste water treatment plant and describe the benefits of each unit.

(12 marks)

Q4:- A/ A stream with BOD 2 mg/l and saturated with DO has a normal flow of 2.26 m^3/s and receives a sewage effluent , also saturated with DO , of 0.755 m^3/s with BOD 30 mg/l . Determine the DO deficits over the next five days and hence plot the sag curve. Calculate the critical DO deficit and the time at which it occurs . Assume temperature is 20 °C throughout. Saturation DO at 20°C is 9.17 mg/l , K1 for effluent / water mixture is 0.17 / day , K_2 for stream is 0.4 / day .

(13marks)

B/ Write short notes on the following :-

1- The factors that affect the coagulation process.

2- The common methods used for disinfection of water.

3- The method of filteration and backwashing of filters and show it by drawings of rapid sand filter.

(12marks)

Q5:-A/ Rapid sand filter L= 9m , W= 4.5 m after filtering 20000 m^3 /d in 24 hr period , the filter is backwash at a rate 0.6 m / min. The filter is designed with 4 trough find :-

1- Filtration rate.

2- Quantity of wash water flow in each trough.

3- Dimension of trough of square cross section.

(13marks)

B/ Draw a sketch showing bacterial growth curves based on (number and mass of organisms).

(12marks)

Q1/A/ Sol. :

(a) $t^2 = \frac{2}{k} \log \frac{N_o}{N_t}$

$\text{Kill} = 1 - \frac{N_t}{N_o}$

$0.9999 = 1 - \frac{0.2}{N_o}$

$N_o = 2000 \text{ mg/l}$

$t^2 = \frac{2}{10^{-2}} \log \frac{2000}{0.2}$

$t = 28 \text{ s}$

(b) $0.9999 = 1 - \frac{1}{N_o}$

$\frac{1}{N_o} = 10^{-4} \Rightarrow N_o = 10\,000$

$t^2 = \frac{2}{10^{-5}} \log \frac{10\,000}{1}$

$t = 894 \text{ s}$

Q1/B/

(1) ① Graphical method , Arithmetic method

$\frac{dp}{dt} = k_a$

$dp = k_a \, dt$

$P_f = P_i + K_a (t_f - t_i)$

$\therefore K_a \frac{P_f - P_i}{t_f - t_i} = \frac{P_i - P_e}{t_i - t_e}$

- Geometrical method: $\frac{dp}{dt} = k_g P$

Comparative method

Ratio and Correlation method:

$$\frac{P_f}{P_f'} = \frac{P_i}{P_i'} = k \text{ (constant)}$$

2/ Impurities of Water

- Suspended
  - Bacteria
  - Algae
  - Protozoa
  - Viruses
  - Silt, clay
  - colloids
- Dissolved
  - Salts
    - Cations: Ca^{+2}, Mg^{+2}, Fe^{+2}, Mn^{+}
    - anions: HCO_3^-, $CO_3^=$, $SO_4^=$, Cl^-
  - organics: color, odor, taste, toxicity
  - Gases: O_2, CO_2, H_2S

3/ صفات الرمل والكلس

الرمل: أو هو مادة كوسط للترشيح، خالي من الأوساخ، صلب، مقاوم بلوري، لا يفقد أكثر من 5٪ من الوزن بعد وضعه في حامض HCl بنسبة 1/40 طبقة في ساعة، حجم الرمل 60 - 70 سم مكعب متر 0.45 - 0.55 mm

عامل التجانس لا يتجاوز $1.2 \leq U.C \leq 1.7$

الكلس: يوضع الكلس بحجم أوسط طبقات حيث تكون الطبقات العليا حاوية على حجم الصغير، صلب، صدور، مقاوم، الوزن التقريبي 1600 كغم/م³ خالي من الشوائب، غير حاوي على الطين، الرمال، تربة عضوية، مقاوم أو مواد غريبة، حجم 400 - 600 mm

Q2/A/ Sol.

Average domestic demand = 22000 * 600 = $13.2 * 10^6$ l/d

Maximum daily demand = 1.8 * ave. = $23.76 * 10^6$ l/d

$F = 18 C \sqrt{A}$

$= 18(1)\sqrt{1000 * 10.76 * 6}$

$= 4574$ gpm $= 17\,288$ l/min $= 24.89 * 10^6$ l/d

Maximum Rate $= 23.76 * 10^6 + 24.89 * 10^6$

$= 48.65 * 10^6$ l/d

$= 2211$ l/c/d For 10 hours

The total flow required during this day would be:-

$23.76 + 24.89 * \frac{10}{24} = 34.13 * 10^6$ l

$= 1551$ l/c/d

Q2) B/

1- BOD: Bacteria placed in contact with organic material. will utilize it as a food source. In the utilization the organic material oxidized to stable end product such as CO_2 & water. the amount of oxygen used in this process is called BOD and is considered to be a measure of the organic content of the water.

2)

1- Dilution

2- Current assist in dispersion

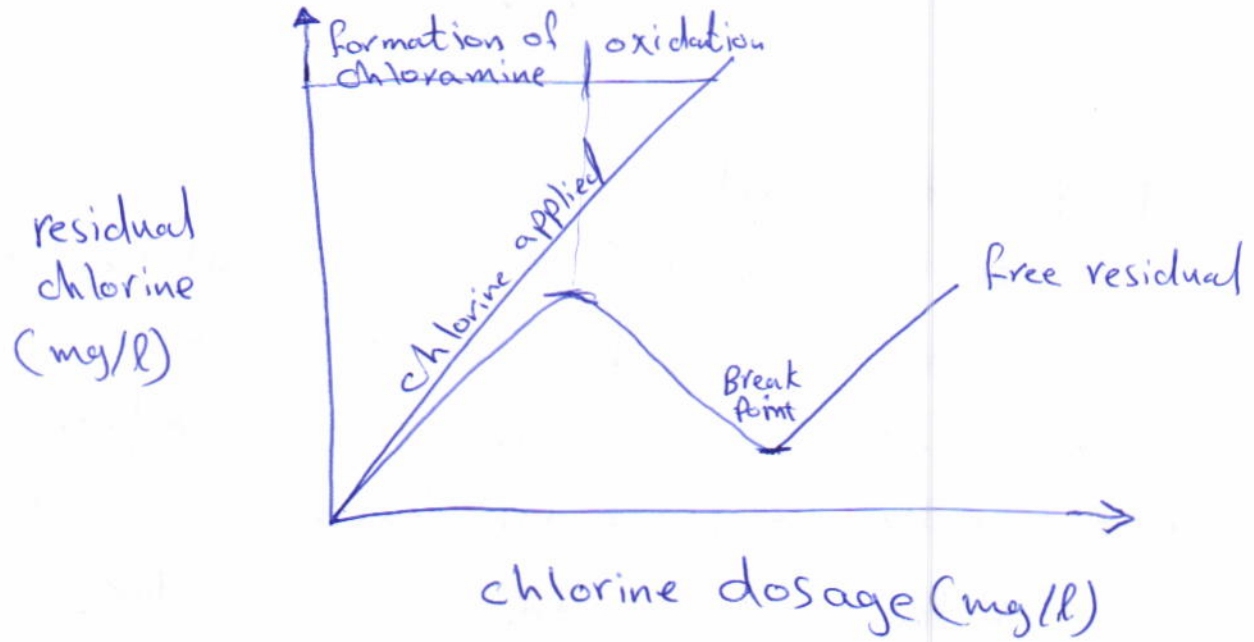
3- Sedimentation : Suspended solids are removed by settling if the stream velocity is less than the scour velocity

4- Bottom deposits and runoff

5- Sunlight.

6- Temperature.

3) The chlorine demand of water depends upon the organic and inorganic Substance Present ---- chloramine & other chloroorganics compounds, the oxidation complete rise in the chlorine residual, free chlorine, the point at which this take place is called " break point"



Q3) A/

① $V_s = \frac{g}{18\mu}(S.G-1)\rho_w \cdot d^2$

$= \frac{980}{18*1.03}(100)(1.2-1)(1)\left(\frac{0.06}{10}\right)^2$

$V_s = 0.038\ cm/s = 0.38 * 10^{-3}\ m/s = 1.368\ m/hr$

$= 32.8\ m/d = SOR$

② $V_h = 0.25\ m/min = 0.25*60 = 15\ m/hr$

$V_h = \frac{Q}{WH} \Longrightarrow Q = 15\,WH\ m^3/hr$

$SOR = \frac{Q}{WL} \Longrightarrow Q = 1.368\,WL\ m^3/hr$

$Q = \frac{Vol.}{time} = \frac{WLH}{2}$ $\quad L = 2W$

$\therefore Q = \frac{2W^2H}{2} = W^2H\ m^3/hr$

$15\,WH = W^2H \longrightarrow$ **W = 15 m**

L = 30 m

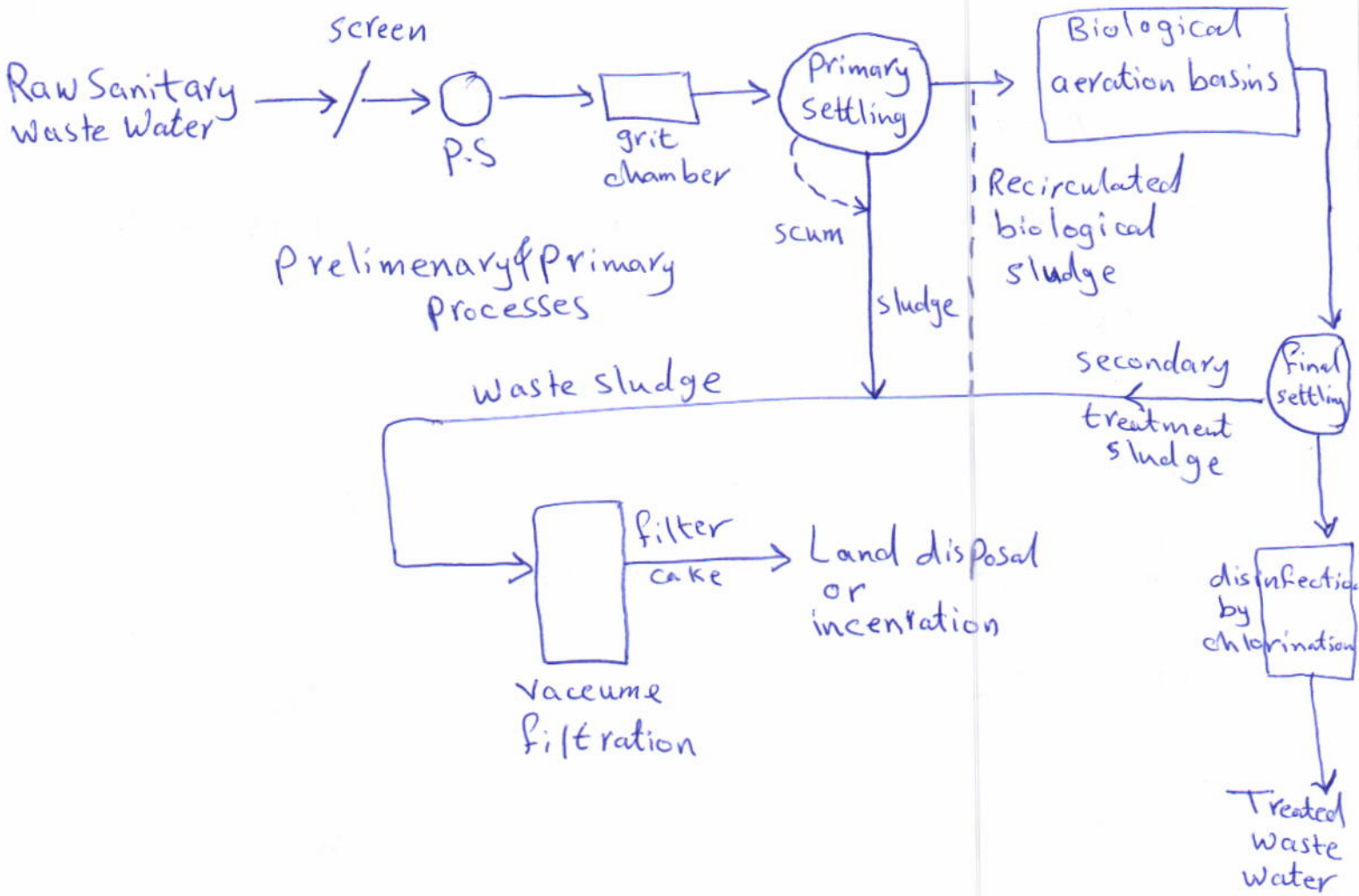
$Q = W^2H \Rightarrow 615.6 = (15)^2 H \Rightarrow$ **H = 2.74 m**

③ weir loading $= \frac{Q}{\text{weir length}}$

$= \frac{615.6\,(24)}{60}$

$= 246.24\ m^3/m/d$

Q3 B/


screen
Raw Sanitary waste Water
P.S
grit chamber
primary settling
Biological aeration basins
scum
sludge
Recirculated biological sludge
Prelimenary & Primary Processes
waste sludge
secondary treatment sludge
final settling
filter cake
Land disposal or incenration
vaceume filtration
disinfection by chlorination
Treated waste water

Q4) A/ Sol.

$$BOD_{min} = \frac{2.26(2) + 0.755(30)}{2.26 + 0.755} = 9 \ mg/l$$

$$L_a = BOD_{ult} = \frac{BOD_{mix}}{1-10^{-k_1 t}} = \frac{9}{1-10^{-0.17*5}}$$

$$= 10.48 \ mg/l$$

تطبق العلاقة التالية لايجاد العجز خلال 5 أيام

$$D_t = \frac{k_1 L_a}{k_2 - k_1}\left(10^{-k_1 t} - 10^{-k_2 t}\right) + D_a \, 10^{-k_2 t}$$

$$D_a = D_s - D_r = 0$$

$$t_c = \frac{1}{k_2 - k_1} \log\left\{\frac{k_2}{k_1}\left[1 - \frac{D_a(k_2-k_1)}{L_a k_1}\right]\right\}$$

0

$$t_c = \frac{1}{0.4 - 0.17} \log\left\{\frac{0.4}{0.17}\right\} = 1.61 \ day$$

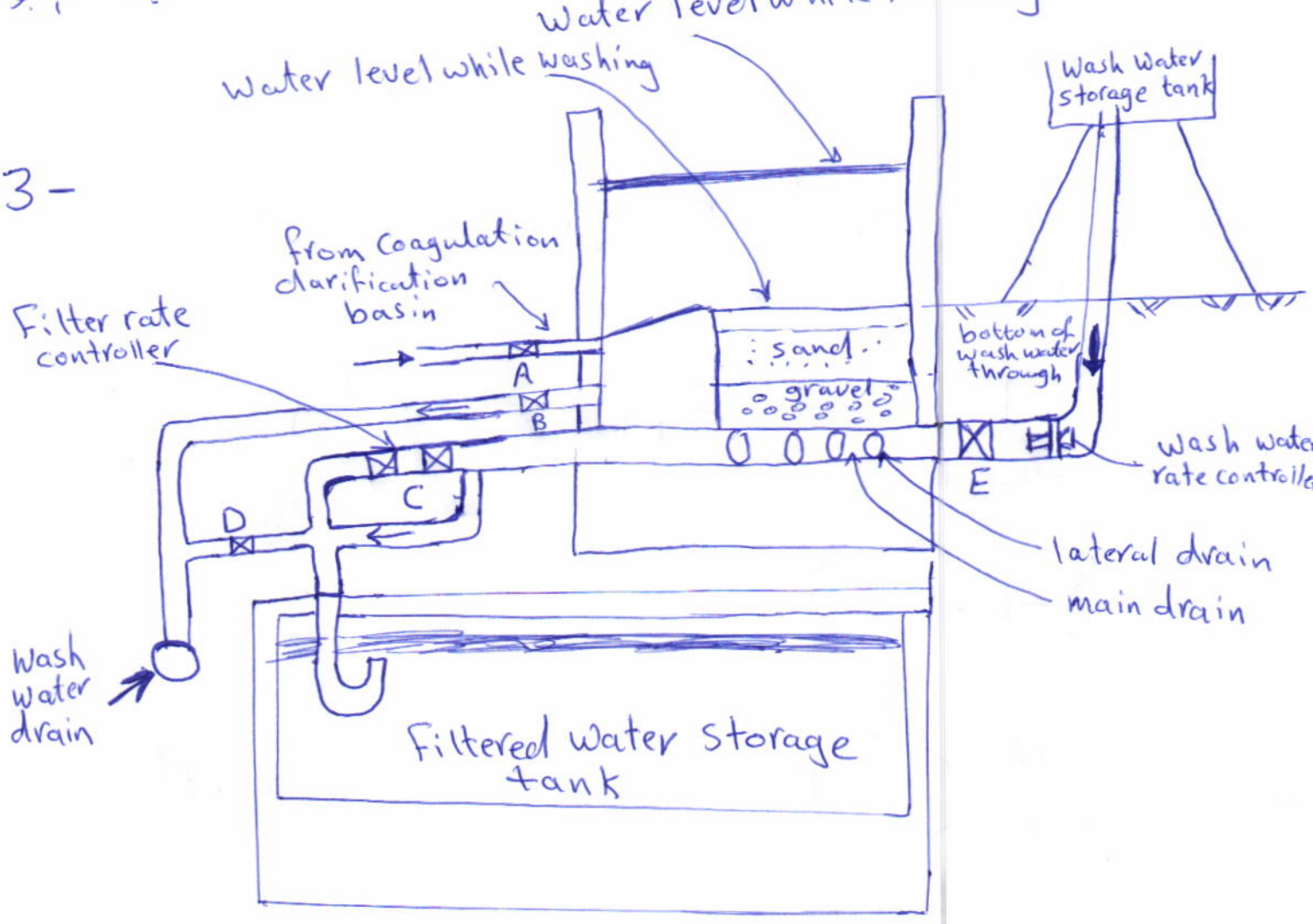
$$D_c = \frac{k_1}{k_2} L_a \, 10^{-k_1 t_c}$$

$$D_c = \frac{0.17}{0.4}(10.48)(10)^{-0.17*1.61} = 2.36 \ mg/l$$

Q4) B/ 1- توحيد المادة، كمية وخواص المواد العضوية
pH، الخلط السريع وفترة التكليس وسرعة الجاذبية
درجة الحرارة، القاعدية، خواص الايونات في المادة

2- وسائل التعقيم: ① الطرق الفيزيائية وتتم المعالجة بالحرارة
ترفع درجة الحرارة الى 100°م ولمدة 15 - 20 دقيقة لقتل الجراثيم
- استخدام الاشعة فوق البنفسجية حيث تمر المياه بحرفة لتعرضها في الاشعة فوق البنفسجية لطول موجة 200 - 360 نانومتر.
- استخدام ايونات المعادن مثل الفضة والنحاس
- اشعة الشمس
② الطرق الكيميائية: وتتم المواد الكيميائية المؤكسدة (مركبات تستقبل الالكترونات) لتطهير المياه، ومثال ذلك غاز الكلور ومركبات الكلور، الأوزون، اليود، برمنكنات البوتاسيوم

3-



Q5) A/ sol.

$A_s = W * L$

$= 4.5 * 9$

$= 40.5\ m^2$

① filtration rate

$$V_f = \frac{Q}{A_s}$$

$$= \frac{20\,000}{40.5}$$

$= 493.8\ m/d$

② Quantity of wash water flow in each trough $= V_b \cdot A_s \cdot t \cdot$ no. of filter

Assume $t = 15$ min

$= 40.5 * 0.6 * 15 * 1$

$= 364.5\ m^3$

③ $$Q = \frac{V_b \cdot A_s}{\text{no. of trough}}$$

$$= \frac{0.6 * 40.5}{4}$$

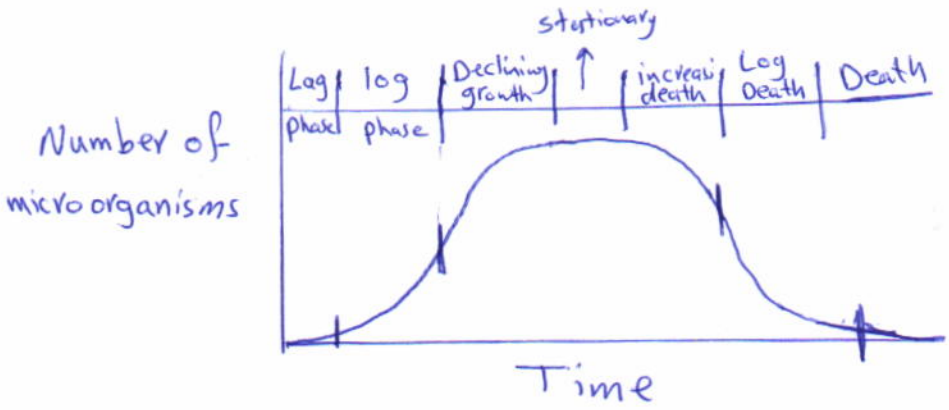
$= 6.075\ m^3/min = 0.101\ m^3/s$

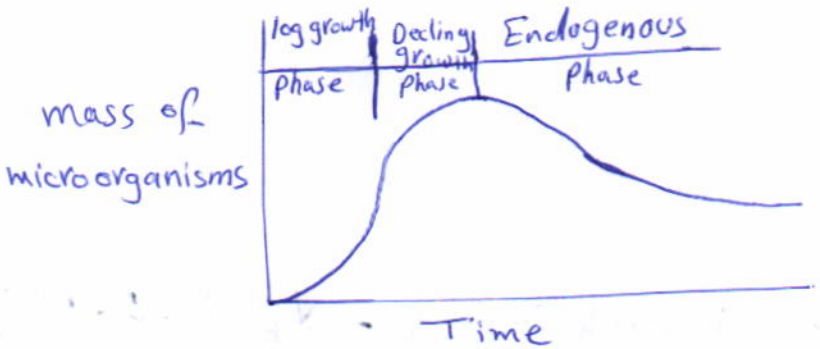
$y = 1.73 \sqrt{Q^2/gy^2}$

$y^5 = (1.73)^3 (Q^2) \frac{1}{g} = (1.73)^3 (0.101)^2 \left(\frac{1}{9.81}\right)$

$y = b = 0.352\ m = 35.2\ cm$

Q5 B/


stationary
Lag phase
log phase
Declining growth
increasi death
Log Death
Death
Number of microorganisms
Time


log growth Phase
Declining growth phase
Endogenous Phase
mass of microorganisms
Time