Kurdistan Regional Government-Iraq
Salahaddin University-Erbil
College of Engineering
Civil Engineering Department

Bank of Questions (2021-2022)
Date: May 23, 2022
Subject: Water Supply and Sewerage
4th year student

Theoretical part (prepared by Prof. Dr. Shuokr Qarani Aziz):

Q.1) Differentiate between physical and chemical experiments of water.

Q.2) Show components of elevated tanks.

Q. 3) Polybutylene pipe has excellent properties for use as water supply pipework, why?

Q. 4) List advantages of impounded reservoirs in water supply system.

Q.5) List factors affecting coagulation and flocculation processes and explain purpose of using coagulant aids in coagulation process.

Q.6) Explain flocculation process, then sketch horizontal and vertical paddles.

Q.7) Explain canal intake.

Q.8) List potential (possible) ways for entering impurities to water.

Q.9) List aims of using valves.

Q.10) Draw compressed air method and flash mixing method.

Q.11) Differentiate between slow and rapid sand filters.

Q.12) In disinfection process, exemplify (show) poor and superior baffling in basins.

Q.13) Draw a typical wastewater treatment plant.

Q.14) List requirements for design of well in river intake.

Q.15) Explain radiological characteristics of water.

Q.16) The use of polypropylene has been increasing since the late 1990s, why?

Q. 17) List factors affecting bacterial efficiency of chlorine.

Q.18) Sketch separate and combined sewer systems.

Q.19) List points that should be considered in collection of water samples.

Q.20) Sketch a typical river intake.

Q.21) Explain needle valve.

Q.22) Explain the variation of water consumption during 24 hours.

Q.23) Classify the impurities in water according to the source of contaminants.

Q.24) Clarify (explain) the critical time in water hammer.

Q.25) Draw a reservoir intake.

Q.26) Explain pre-chlorination, then show break point chlorination.

Q.27) Mixing tank with buffle walls is a method for mixing coagulant with untreated water, sketch this method.

Q.28) Define chemical experiments of water.

Q.29) Properties of PEX pipes are:

Q.30) Sketch a typical canal intake.

Q.31) Differentiate between pre-chlorination and post-chlorination.

Q.32) The factors should be considered in selection of pipes are:

Q.33) List requirements for well (or tower) for river intakes

Q.34) Differentiate between disinfection and sterilization.

Q.35) Surface runoff coefficient changes from one place to other places and it generally depends on the factors:

Q.36) Show superior baffling for the disinfection process.

Q.37) Unplasticised polyvinylchloride is the most widely used plastic pipes for water supply and drainage systems, why?

Q.38) Write uses of PP-R and PP-B.

Q.39) Explain the function of using wash out valve in the pipe line system.

Q.40) The amount of fresh water decreases due to:

Q. 41) Explain water hammer.

Q.42) A mid size city recorded populations of 113000 and 129000 in the May 2000 and May 2010 census, respectively. Estimate the population in February 2019 by using arithmetic and declining growth methods.

Q.43) A City has following record population:

Year	Population
1971	50 000
1991	110 000
2011	160 000

Calculate expected population in 2031, use Logistic Curve Method.

Q.44) The population of a city in three consecutive (repeated) years i.e. 1994, 2004 and 2014 was 80 000, 250 000 and 480 000, respectively. Average water consumption is 300 LPCD. Determine: 1) The expected population in 2024 by using logistic curve method, 2) The minimum, average and maximum water demand of the city in year 2024.

Q.45) A community with a population of 40000 has an average water consumption of 0.45 m^3 per capita per day. Noncombustible materials with C factor of 0.8 are used for construction of buildings. Each building has five floors. Area of one floor is 800 m^2. According to the standards, the fire flow must be maintained for 10 h for required fire flow of greater than 8505 L/min. Hydraulic gradient (S) is 0.018, C value of the pipe material is 110, and K= 0.849. Determine:

1) Total required amount of water during a fire (L/d).

2) Diameter of the pipe for the total flow.

Q.46) The population data for a town is as follows: in 1990=15000, in 2000=18000, and in 2010=20000. Required:

1) Determine the population in the year 2030 by using declining growth method.

2) Estimate minimum, average, and maximum water demands for the city in 2030, assume average water consumption is 300 LPCD.

3) Explain water consumption for various uses.

Q.47) Water is delivered through a 900 mm diameter steel pipe, with a flow velocity of 108 m/min. The pipe line contains a valve which is situated at 1.6 km from the reservoir. Compute T_{cr} and the water hammer pressure (kg/cm^2) developed by the closure of the above valve. The thickness of pipe shell is 22 mm. Bulk modulus of water 2.07 $x10^8$ kg/m^2. E of pipe =2.1 x 10^{10} kg/m^2.

Q.48) A city has a population of 120000. Average daily demand is 320 LPCD. Maximum daily demand is 200 % of the average demand. Number of tanks=6. Four hourly demand is given in the following table.

Period of day	**% of demand**	**Period of day**	**% of demand**
12-4 a.m.	20	12-4 p.m.	130
4-8 a.m.	50	4-8 p.m.	170
8-12	160	8-12	70

It is required to:

1) Determine the capacity of one tank (m^3).

2) Show the variation of time (h) versus volume of water (m^3) for the cumulative demand and the cumulative constant supply.

Q.49) A city has a population of 100000 and is supplied with 144 litres per head per day of water. The hourly variation in the demand is given in the following table. Determine the capacity of the tank based on the average demands.

Hours	Ratio of actual demand with average hourly demand	Hours	Ratio of actual demand with average hourly demand
12 Night -2 A.M.	0.3	12 Noon -2 P.M.	0.5
2 A.M. - 4 A.M.	0.4	2 P.M. - 4 P.M.	0.6
4 A.M. - 6 A.M.	1	4 P.M. - 6 P.M.	1.0
6 A.M. - 8 A.M.	2	6 P.M. - 8 P.M.	1.0
8 A.M. - 10 A.M.	1.5	8 P.M. - 10 P.M.	1.2
10 A.M. – 12 Noon.	1	10 P.M. – 12 Night	0.8

Q.50) Table below shows the hourly demand for the maximum daily. Assuming a 24 hour pumping at uniform rate. Determine the storage capacity of equalizing reservoir based on average demand. What will be the uniform pumping rate?

Time	Average hourly demand rate (L/min)	Time	Average hourly demand rate (L/min)	Time	Average hourly demand rate (L/min)
12	0	8	20500	4	15500
1 a.m.	8000	9	22500	5	16000
2	9000	10	21500	6	16500
3	10500	11	20000	7	17000
4	11000	12	18000	8	17000
5	12000	1 p.m.	16000	9	15000
6	15000	2	15000	10	12000
7	17500	3	15000	11	10000
				12	9000

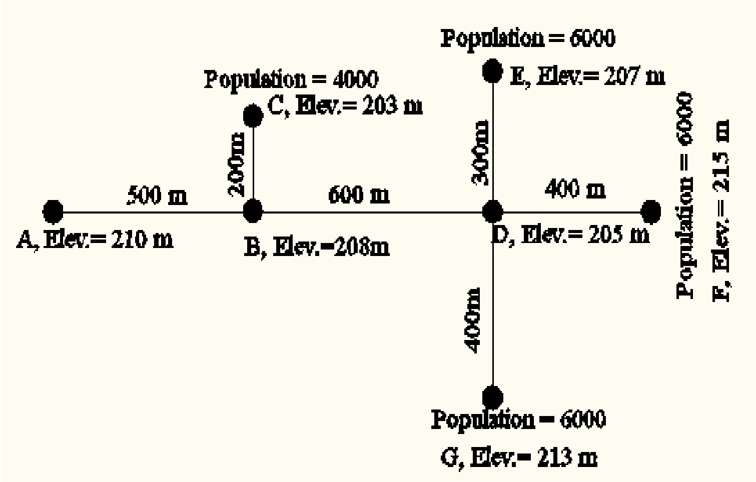
Q.51) A large service reservoir supplies water to a residential area with population of 60000 persons. Average daily consumption is 200 LPCD. Assume that the maximum daily demand is 1.6 times the average demand. Assume velocity = 1.2 m/s. C value is equal to 100. Determine size of the supply pipe and S value, use Hazen William's formula.

Q.52) Main pipes of a water distribution system are shown in the figure. Average daily demand is 250 LPCD. Maximum and minimum daily demands of average demand are 200 % and 50 %, respectively. Maximum demand on hourly basis is 150 % of the average demand. Height of elevated tank at location A=25m. C=100, K=0.849. Assume S=0.005 for all pipes.

Determine:

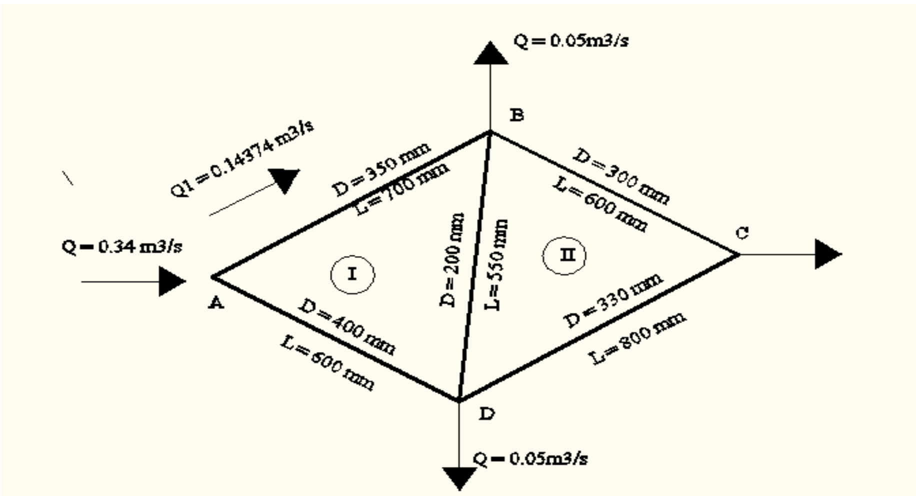
1) Diameter of all the pipes (cm).

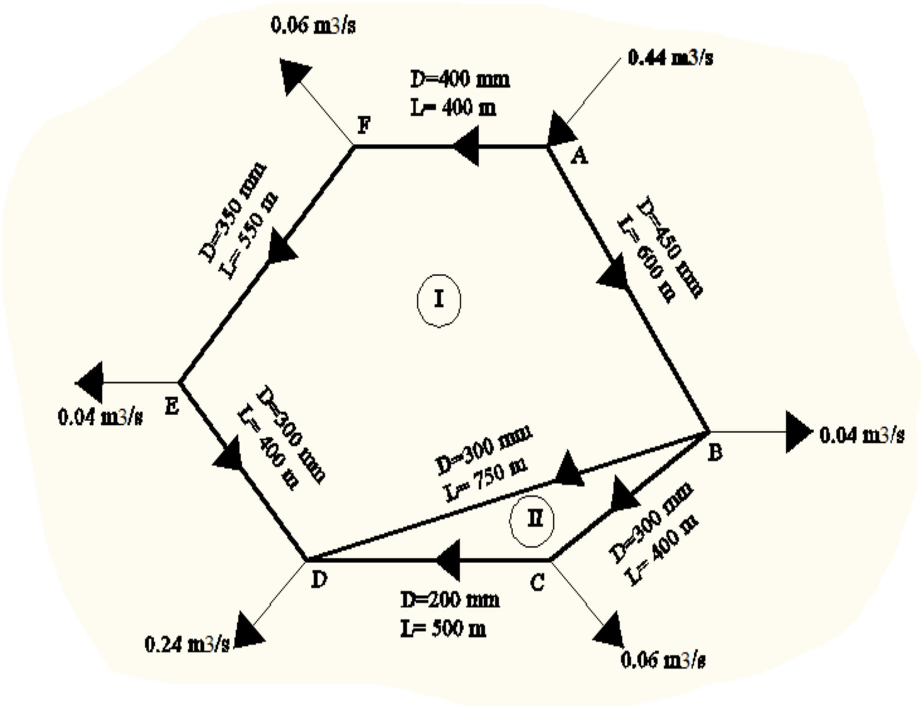
2) Available pressure at locations C and G (as a head of water).



Q.53) A simplified pipe network is shown below. The water enters the system at node A. C value is equal to 100. Assume $Q_{A\text{-}B}$= 0.14374 m^3/s. In Loop II, $Q_{B\text{-}D}$ = 0.01391 m^3/s. Locations of B, C and D are 8 m lower than the location of A. Continue calculations until the $\Delta Q \leq 0.003$ m^3/s.

Required: 1) Determine Q at node C, 2) If the residual head at point C is 16 m as head of water, find the required head at point A, and 3) When ΔQ become ≤ 0.003 m^3/s, calculate the final Q in the pipes without determining H_L.





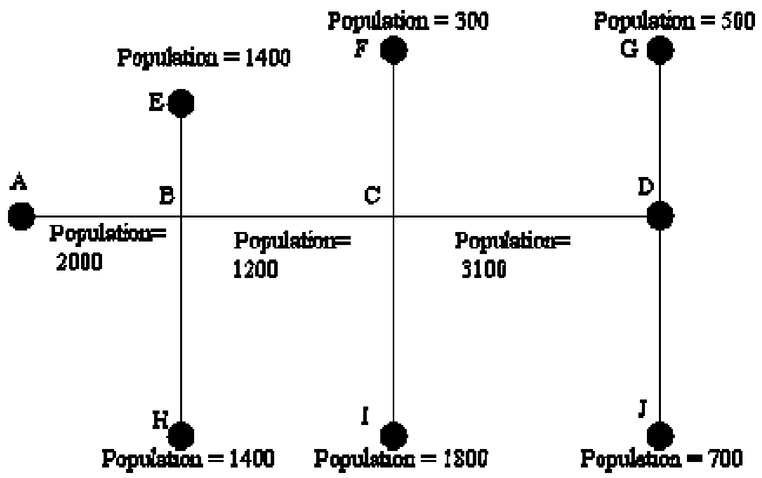
Q.54) A simplified water distribution system is shown in the figure. The water enters the system at node A. Assume Q_{A-B} and Q_{B-C} are 0.242 m^3/s and 0.094 m^3/s, respectively. Directions of water flow in the pipes are shown in the figure. Locations of B, C and E are 6 m lower than the location of A. While, locations of D and F are 4m higher than location of A. For both loops, ΔQ should be less than or equal to 0.003 m^3/s. C value=100 and K=0.849. Suppose available head at A is 40m (as head of water). Determine residual head at point D.

Q55) A simplified pipe network is shown in the figure. The water enters the system at node A. Values of C and K are 120 and 0.849, respectively. Assume QA-B = 2.987 m3/min, QA-D = 1.813 m3/min, and QD-C = 0.314 m3/min. Continue calculations until $\Delta Q \leq 0.15$ m3/min. Calculate HL in all pipes in the system.

Q.56) A typical layout of pipes in dead end system is given in the figure. The rate of supply is 180 LPCD and the populations in different residential blocks of houses are given in the figure itself. Peak supply is taken as 2.5 times the average rate. Elevation of the bottom of elevated tank at location A is 150 m. while, elevations of points A, B, C, and D are 130m, 129m, 131m and 128m, respectively. C=100, K=0.849. Assume S=0.005 for all pipes. AB, BC, and CD lengths are 300m, 400m, and 500m, respectively. Determine:

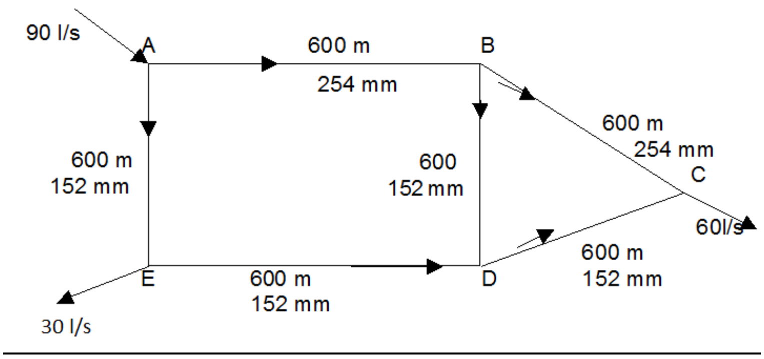
1) Diameter of pipes AB, BC, and CD (cm).

2) Available pressure at locations B, C, and and D (as a head of water).



Q.57) A simplified water distribution system is shown in the figure. Assume $Q_{A\text{-}B}$ and $Q_{B\text{-}C}$ are 65 l/s and 52 l/s, respectively. Lengths and diameters of the pipes are given in the figure. For the given loops, ΔQ should be less than or equal to 2 L/s. C value=130 and K=0.849. Locations of B and C are 3 m higher than the location of A. While, locations of D and E are 2m lower than location of A. Suppose available head at A is 30 m (as head of water). It is required to:

1) Calculate ΔQ (L/s).
2) Calculate residual head at point E (m as head of water).
3) Show the final corrected discharges on the water distribution system.



Q.58) Design an intake well on a river side to supply raw water for a water treatment plant. $Q_{average}$ is 27000 m^3/d. $Q_{minimum}$ and $Q_{maximum}$ are 13500 m^3/d and 54000 m^3/d, respectively. Two wells are proposed. During minimum and average demands one well is in service. While, during maximum demand two wells are to be in service. Detention time of water in the well during minimum demand is 15 minutes. Effective depth of the tank (well) during minimum demand is 10 m. For suction pipes, assume velocity is 1.5 m/s for $Q_{minimum}$. While for penstocks, velocity for $Q_{minimum}$ is 0.6 m/s. Assume velocity for strainers is 0.3 m/s for minimum water demand. Area of the openings is equal to 0.5 of area of the screen (strainer).

Q.59) A clariflocculator tank (i.e. tank is circular with flocculator in the centre and clarifier is surrounding it) treats 5000 000 L/d water. Surface over flow rate is 1000 L/h/ m^2. Detention times for clarifier and flocculation are 180 minutes and 20 minutes, respectively. Depth of flocculation zone is 3m. Power input is 0.08 kW. Assume water temperature = 25 ^oC and $\mu = 0.89*10^{-3}$ N.s/m^2. Determine:

1) Velocity gradient.
2) Diameter of clarifier (m).

Q.60) A water treatment plant treats 250 m^3/h of water. Velocity gradient and Gt values are 30 s^{-1} and 40000, respectively. Dynamic viscosity is $0.89*10^{-3}$ N.s/m^2. Depth of water in the flocculator tank is 5m. Alum is used at a rate of 20 mg/L for the coagulation process. ρ_{alum}=600 kg/m^3. Determine:

1) Diameter of the flocculator tank (m).
2) Power input (kW).
3) The storage volume (m^3) required to provide a minimum of one month supply.

Q.61) A water treatment-plant has four clarifiers treating 0.175 m^3/s of water. Each clarifier is 4.88 m wide, 24.4 m long, and 4.57 m deep. Concentration of suspended solids in the flocculated water and the settled water are 330 mg/L and 27 mg/L, respectively. Concentration of solids in dried sludge is 2.5%. Determine: (1) overflow rate, (2) horizontal velocity, (3) weir loading rate assuming the weir length is 2.5 times the basin width, (4) quantity of removed sludge from the water in m^3/d, and (5) efficiency of the clarifier.

Q.62) Determine the dimensions for two rectangular primary clarifiers to settle 3400 m^3/d of water based on the following criteria: an overflow rate of 32 m^3/m^2.d, a water depth of 2.4m, weir loading of 125 to 250 m^3/m.d and length/width ratio in the range of 3/1 to 5/1. The suitable width for a standard-sized sludge-removal mechanism is 4m. Calculate: 1) the detention time (min), 2) weir length (m), and 3) amount of alum required per day, concentration of alum = 15 mg/L.

Q.63) A plain circular sedimentation basin treats 3 million litres of water per day. The sedimentation tank settles all particles greater than 0.002 cm. Specific gravity of particles = 2.65. Depth of water in the tank = 3m. Kinematic viscosity of water = 0.873* 10^{-6} m^2/s; dynamic viscosity = 0.87 * 10^{-3} Pa.s, and density of water = 996.787 kg/m^3 at 26 ^oC. Determine:

1) Settling velocity (mm/s) of 0.002 cm particles.
2) t_s (min).
3) Radius of the tank (m).

Q.64) Define SOR and WLR.

Q.65) A rectangular sedimentation basin is to handle 12000 m^3/d of raw water. A sedimentation basin of width to length ratio of 1/3 is proposed to remove all particles larger than 0.05 mm in size. Assume a specific gravity of 2.62 for the particles and 20 ^oC as the average temperature; determine the basin dimensions. If the effective depth of the tank is 3m, calculate the detention time. At 20 ^oC, μ=1.0087 centipoises and density = 0.99823 $grams/cm^3$.

Q.66) Draw a typical rapid sand filter.

Q.67) A water treatment-plant treats 6300 m^3/h of river water. The treatment plant has 3 clarifies and 12 numbers of filters in the filtration unit. Radius of each clarifier is 10 m. Effective depth of clarifiers is 4m. Length and width of each filter are 14 m and 6 m, respectively. Turbidity values in the river water, settled water, and treated water are 85 NTU, 30 NTU, and 6 NTU, respectively. Determine:

i) Detention time of water in the clarifiers (min).

ii) Filtration rate (m^3/m^2 per day).

iii) Amount of used alum (kg/d), if jar test showed that the optimum coagulant dose= 20 mg/L.

iv) Removal efficiencies of the filter units and the treatment-plant.

Q.68) A rapid sand filter is to be designed for a water treatment-plant (WTP). The WTP treats 24000 m^3/d. Number of filter tanks are10. Filtration rate is 5 m/h. Porosity and specific gravity of the filter media (sand) are 43% and 2.62, respectively. D_{10} and D_{60} of the filter media are 0.45 mm and 0.8, respectively. Determine: 1) the particle size of garnet which have settling velocity equal to that of sand with a diameter of 0.62 mm, specific gravity of the garnet=4.15; 2) fluidization velocity of the filter bed; and 3) Length and width of the filter tank, L=1.25 W.

Q.69) A set of rapid sand filters treats water for a population of 80 000. Rate of water supply is 200 LPCD. The filters are designed to work at 5000 L/h/m^2. Assume 3% of filtered water is used for washing filters once a day. Required time for washing a filter is 30 min. Number of filter units is 3. Total area of perforations = 0.1485 m^2. Total cross section of laterals = 2 x area of perforations. Cross-sectional area of manifold = 1.5 x total cross-section of laterals. Amount of alum used is 400 kg/d. Required:

1) Calculate daimeter of manifold (m).
2) Total number of 12 mm diameter perforations.
3) Calculate dosage of coagulant in the coagulation process (mg/L).

Q.70) A filter unit is of size 5.5 m x 4m. After filtering 5500 m^3 in 24 hours, the filter is back-washed at a rate of 10 L/m^2/s for 10 minutes. Assume washing time is 30 minutes for washing once during 24 hours. Four troughs are used for collecting wash water. Total number of laterals in the filter tank is 36. Total area of perorations = 0.5% * area of filter tank. Total area of perorations = 0.5 * total area of laterals. Assume diameter of perforations is 12 mm. Calculate:

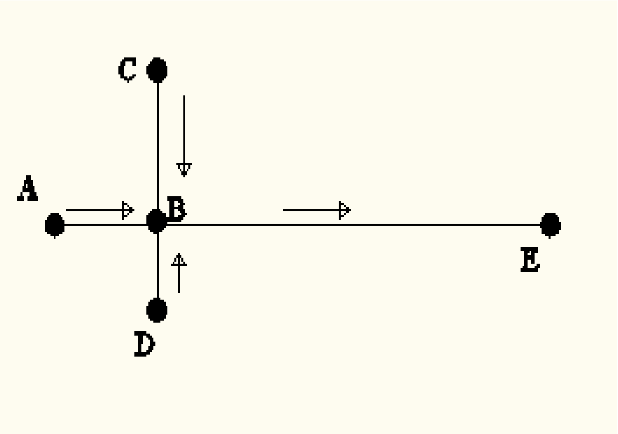
1) The average filtration rate (m/h).
2) Dimensions of troughs (cm), use square section.
3) Diameter of lateral (cm).

Q.71) Find the number of rapid gravity filter units so as to treat 20 million litres per day; assuming that the filter may be washed twice a day and duration of each washing is 15 minutes. Find the of backwashing water required for washing of each unit (m^3/s). Filtration rate is 5000 Litre/m^2/hour. Proposed area for one filter unit = 17.5 m^2. Assume backwashing rate = 0.6 m^3/min/m^2.

Q.71) A water treatment plant treats 20000 m^3/d. Rate of filtration is 120 m/d. Number of filter tanks is 12. Length and width of filter units are 6m and 4m, respectively. Total number of laterals in one filter tank is 40. Total area of perorations = 0.4% * area of filter tank. Assume diameter of perforations is 12 mm. The quantity of water needed for backwashing filter units is 5%. Number of troughs = 2 per one filter tank. Concentration of suspended solids in raw water, settled water, and filtered (treated) water are 600 mg/L, 90 mg/L, and 45 mg/L respectively. Find: 1) Diameter of laterals (cm), 2) Dimensions of troughs in cm, assume b=1.25h, and3) Removal efficiencies (%) of the filtration unit and the treatment plant.

Q72.) Calculate terminal velocity, fluidization velocity and the velocity to expand the filter bed by 10% at 10 ^oC. D_{10} and D_{60} for the filter media are 0.5 mm and 0.8 mm, respectively. Absolute viscosity (μ) at 10 ^oC is 1.3097 centipoises. Specific gravity of the filter media is 2.65; while porosity of the filter media is 45%

Q.73) A proposed storm sewer system for a certain area is shown in the figure.



$i = \frac{3000}{t+15}\ \frac{mm}{hr}$, $n = 0.013, S = 0.5\%$

Initial time of concentration $= 10\ min$. Assume velocity inside sewers=1 m/s.

Sewer AB: C= 0.9, Area= 8000 m^2, L=40m.

Sewer CB: C= 0.85, Area=10000 m^2, L=50m.

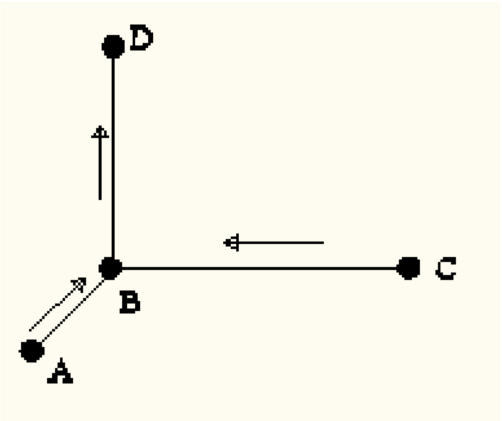
Sewer DB: C= 0.7, Area=7000 m^2, L=30m.

Sewer BE: C= 0.8, Area=12000 m^2, L=150m.

Determine:

1) Diameter (cm) of sewer BE.

2) The velocity (m/s) and discharge (m^3/s) inside sewer CB when the sewer is ½ full.



Q.74) A part of storm sewer system is shown in the figure. Intensity of rainfall is 50 mm/h. Velocity inside sewers is 60 m/min, n=0.013.

Sewer AB: C= 0.2, Area= 10000 m^2, L=45m.

Sewer CB: C= 0.9, Area=15000 m^2, L=140m.

Sewer BD: C= 0.75, Area=12000 m^2, L= 90m.

Determine:

1) Diameter of sewer BD (cm).

2) The velocity (m/s) and depth of water (cm) inside sewer AB when the discharge is 0.5 m^3/min, diameter of Sewer AB= 200 mm, Slope=0.5%.

3) Slope of sewer CB (%).

Q.75) The following data is available regarding various types of area and the corresponding impermeability factors of a town:

No.	Type	% Area	Impermeability coefficient
1	Roofs	15 %	0.9
2	Pavements	20%	0.8
3	Gardens	40 %	0.15
4	Unpaved	15 %	0.2
5	Wooded	10 %	0.05

Total area of the district is 20 hectares. Intensity of rainfall is 50 mm/h. Velocity of water inside sewer is 0.8 m/s. Slope of the sewer is 0.5 %. N= 0.013. Determine:

1) The average coefficient of runoff.

2) Maximum storm water flow (m^3/s).

3) Diameter of sewer (cm).

Q.76) A main combined sewer is to be designed to serve an area of 12 square km with a population density of 250 persons/hectare. The average rate of sewage flow is 250 litres/capita/day. The maximum flow is 100% in excess of average together with rainfall equivalent of 15mm in 24 hours, all of which are runoff. Determine:

1) The capacity of the sewer (m^3/s).

2) Determine the size of the circular sewer (m). Taking the maximum velocity = 3 m/s.

3) Slope of the sewers (%); assume n= 0.012.

Q.77) What is adsorption process?

Q.78) Explain biological treatment.

Q.79) Write the objective of screening process.

Q.80) Define sewage, sewerage, sewer, and sludge.

Good Luck

Practical part (Prepared by Mr. Khasro Kakl):

Q.81) Write reagents for: Hardness test BOD test

Q.82) Define the following terms: DO, MPN, Taste and odour, and pH

Q.83) Why it is prefer to do some tests in the site.

Q.84) List requirements in taking water samples.

Q.85) In the Alkalinity test, Given:

Initial reading=24.2 ml

Final reading= 32.7 ml

Volume of sample = 50 ml

It is required to determine Total Alkalinity as $CaCO_3$(mg/l), then write your comment about the result.

Q.86) Write the procedure for determination of Residual Chlorine in a sample of water.(20Marks

Q.87) Write the indicator and the titrant for the following experiments**.**

1-Total acidity, 2- BOD_5 , 3- Chlorine in bleaching powder, 4-Residual chlorine, 5-pH

Q.88) In the MPN test, Discuss the result 4 – 2 – 0 .

Q.89) Write the procedure for determining the total hardness in a sample of water.

Q.90) Define DO and show graphically the effect of temperature on DO**.**

Q.91) A burette contains $AgNO_3$ with normality of 0.0041N. It was used for titration 25 ml water sample. The initial reading was 40.7 ml. When the colour of the solution became pinkish yellow, the reading on the burette was 45.2 m l. Amount of 0.2 ml titrant used for titration of distilled water. Determine the Chloride content (mg/l) in the sample.

Good Luck