UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2004/2005 Academic Session

October 2004

EAP 581/4 – Water Supply Engineering

Duration : 3 hours

Instructions to candidates:

1. Ensure that this paper contains **FIVE (5)** printed pages before you start your examination.

2. This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only. Marks will be given to the **FIRST FIVE (5)** questions put in order on the answer script and **NOT** the **BEST FIVE (5).**

3. All questions carry equal marks.

4. All questions **MUST BE** answered in English.

5. Each question **MUST BE** answered on a new sheet.

6. Write the answered question numbers on the cover sheet of the answer script.

1. (a) A sample of water from a surface stream is analyzed for the common ions with the following results:
Ca^{2+} = 98 mg/L , Cl^- = 89 mg/L , HCO_3^- = 317 mg/L
Mg^{2+} = 22 mg/L , Na^+ = 71 mg/L , SO_4^- = 125 mg/L

i) Calculate the percent error in the cation-anion balance,
ii) Draw a bar diagram for the water,
iii) Determine the alkalinity of the water,
iv) Determine the total hardness for the water.

Given the atomic weight of the elements:
S = 32, O = 16, Cl = 35.5, Mg = 24, Na = 23, H= 1, C= 12, Ca = 40

(8 marks)

(b) Write short notes on any **TWO (2)** of the following:
i) Indicator organism
ii) Organic constituents of water
iii) Types of water consumption

(6 marks)

(c) Discuss **THREE (3)** laws and legislation available in Malaysia concerning water supply.

(6 marks)

2. (a) With the aid of a sketch diagram, describe briefly on the importance of each typical water treatment process involved for the production of potable water supply. The function of each process must be clearly stated.

(8 marks)

(b) Population data for certain area are shown in Table 1. Calculate the projected population in the rural areas in 2030 using the following methods:

(i) Arithmetic
(ii) Geometric
(iii) Incremental increase and
(iv) Decreasing rate of increase

Table 1

Year	1980	1990	2000
Total population	70,000	78,000	88,000
Percentage of urban population	30	35	38

(12 marks)

3. (a) Explain the importance of jar test with respect to water treatment process which is carried out at the water treatment plant.

(3 marks)

(b) Describe briefly on the guidelines used for the design and construction of horizontal flow baffled channel flocculators.

(5 marks)

(c) A water treatment plant is designed to cater a population of 20,000 and per capita consumption is 230 litres per day. Coagulation process involves with the construction of one mechanical rapid mixing tank with a velocity gradient, G equals to $750s^{-1}$ and a retention time of 1½ minutes. In the flocculation process, two tanks of equal size are constructed in series. Velocity gradients for the first and second tanks are $70s^{-1}$ and $40s^{-1}$ respectively. Retention time in each tank is 10 minutes with the dynamic viscosity of water $1.145x10^{-3}$ Nsm^{-2}. Calculate the following parameters:

(i) volume of the coagulation tank
(ii) power input in the coagulation tank
(iii) volume of the flocculation tank
(iv) power input at each of the flocculation tank

(12 marks)

4. (a) An ideal horizontal flow sedimentation tank is considered to be divided into 4 zones. With the aid of a sketch diagram, explain briefly on these zones with respect to their functions.

(4 marks)

(b) Several classes of settling behaviour may be distinguished on the basis of the nature of the particles to be removed and their concentration. With the aid of a sketch diagram, explain briefly on the principle of Sedimentation Class II, which involved settlement of dilute suspensions of flocculent particles.

(6 marks)

(c) A horizontal sedimentation tank has a capacity of 5 million litres per day (MLD) with a surface loading of 30m/day. The minimum retention time in the tank is 2 hours. The tank is required to be designed with a length to breadth ratio of 4:1. Determine the dimensions of the tank and the length of the outlet weir.

(10 marks)

5. (a) A layer of filter has a flow rate of 2 litres/m^{2}s with a concentration of suspended impurities of 50 mg/L (density 1003 kg/m^3). The concentration of impurities at the time was 0.02 m^3/m^3 of sand bed and the rate parameters for $\lambda_0 = 10$ m^{-1}, $\phi = 22$ mm^{-1}, c = 1200 m^{-1} and the initial porosity was 0.4. Calculate the volumetric proportion of deposited impurities one hour later at that position of the filter. The following equations may be useful to facilitate your calculation:

$$\lambda = \lambda_0 + c\sigma - \frac{\phi\sigma^2}{f_0 - \sigma}$$

$$\frac{\partial\sigma}{\partial t} = \lambda V_w C$$

(5 marks)

(b) With the aid of a sketch diagram, explain briefly on the principle of reverse osmosis process with regards to two aqueous solutions separated by a membrane. (5 marks)

(c) Figure 1 shows a reticulation system in a housing estate. Estimate the flow rate in each pipeline using Hardy-Cross Method and Hazen-William formula up-to two iteration. Adopt Hazen-Willian coefficient C as 100. Use an initial flow rate of 60 litres per second (lps) from point A to B. Given that the parameters for the pipes are as follows:
Pipe AB: length = 1500m and diameter = 300 mm
Pipe BC: length = 800m and diameter =250mm
Pipe CD: length = 600m and diameter =250mm
Pipe AD: length= 900m and diameter = 300mm.

The following formula may be useful:

$$H_L = \frac{12.25x10^9}{D^{4.87}} L\left(\frac{Q}{C}\right)^{1.85}$$

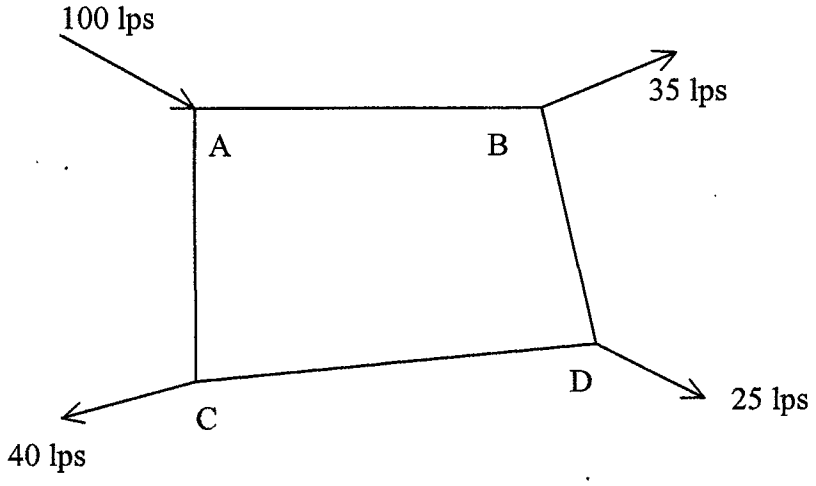

Figure 1

(10 marks)

6. (a) With the aid of a sketch diagram, describe briefly the principle of a balancing reservoir with respect to water supply engineering.

(4 marks)

(b) Discuss briefly on the causes of non-revenue water and its impact on water supply industry particularly in Malaysia.

(6 marks)

(c) USM engineering campus is located along Kerian River. The campus would discharge wastewater containing 250mg/L of total suspended solids (TSS) and 175mg/L of Biological Oxygen Demand (BOD) at a rate of $1.1m^3/s$. The Kerian River has an average velocity of 0.5m/s, an average width of 5 m, and an average depth of 0.9m with TSS concentration of 50 mg/L and BOD concentration of 30mg/L.

i) Determine weather the campus discharge result in violation of the Standard B Malaysian Environmental Act 1974 of 100mg/L for TSS and 50mg/L for BOD.

ii) Determine the concentration of both TSS and BOD at 500m downstream

iii) Determine at what distance water supply can be extracted.

(10 marks)

- ooo O ooo -