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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	GROUNDWATER TECHNOLOGY
COURSE CODE	:	BNA 40803
PROGRAMME CODE	:	BNA
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL QUESTIONS** IN **SECTION A** AND **FOUR (4) QUESTIONS** IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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SECTION A

Q1 (a) Describe in your own words according to groundwater occurrence in terms of hydrology perspective.

(4 marks)

(b) Rewrite **FOUR (4)** characteristics of groundwater according to water movement, water quality and quantity effects.

(8 marks)

(c) Compare **TWO (2)** situations with aided sketch of groundwater table interacts for hydraulically connected system with the stream bed.

(i) gaining stream

(ii) losing stream

(8 marks)

SECTION B

Q2 (a) Define the terms as follows:
(i) Groundwater
(ii) Aquifer

(3 marks)

(b) Explain in your own words the principles of groundwater flow based on force potential and hydraulic head.

(4 marks)

(c) Give an example of each main factor as follows the ability the ground condition to hold water:
(i) porosity
(ii) permeability

(6 marks)

(d) Differentiate **FOUR (4)** aquifer characteristics according to confined and unconfined aquifer.

(7 marks)

Q3 (a) Define the terms as follows:
(i) Steady flow
(ii) Unsteady flow

(4 marks)

(b) Formulate **TWO (2)** ways of hydraulic head can be measured.

(4 marks)

(c) By referring to **Figure Q3(c),** formulate the equivalent permeability for flow perpendicular to the horizontal layers.

(4 marks)

(d) A field sample of an unconfined aquifer is packed in a test cylinder. The length and the diameter of the cylinder are 50 cm and 6 cm, respectively. The field sample is tested for a period of 3 min under a constant head difference of 16.3 cm. As a result, 45.2 cm^3 of water is collected at the outlet. Determine the hydraulic conductivity of the aquifer sample and identify the type of soil classification as shown in **Table Q3(d).**

(8 marks)

Q4 (a) Give a simple method to find water underground.

(2 marks)

(b) Show with aided sketch the head of:

(i) Well A from mean sea level

(ii) Elevation of bottom well (point A)

(5 marks)

(c) Briefly explain the reason why the pH value measurement must be monitored for groundwater quality.

(5 marks)

(d) Explain the relationship between water levels in wells and groundwater quality and quantity for situation as follows:

(i) unconfined (water-table) aquifers

(ii) confined aquifers

(8 marks)

Q5 (a) List **THREE (3)** apparatus normally used for pumping test.

(3 marks)

(b) Identify **FOUR (4)** purposes of test pumping water well.

(4 marks)

(c) A step test was carried out four 2h steps. The **Table Q5(c)** shows data were obtained for yield (Q) and corresponding drawdown (s_w) in the pumping well. Determine:

(i) Value of losses

(ii) Percent of well efficiency drops

(13 marks)

Q6 (a) List **SIX (6)** applications of artificial recharge.

(3 marks)

(b) Describe the function of recharge estimation according to $R = \delta y \Delta h$.

(4 marks)

(c) Design with aided sketch of the direct subsurface recharge for access deeper aquifers and require less land than the direct surface recharge methods.

(5 marks)

(d) An unconfined aquifer of clean sand and gravel is located between two fully penetrating rivers with hydraulic conductivity $K = 1 \times 10^{-2}$ cm/s. The aquifer is subject to a uniform recharge of 1.6 m/year. The water surface elevations in rivers A and B are 8.5 m and 10 m, respectively, above the bottom. Given L= 460m and estimate:

(i) maximum elevation of the water table and the location of groundwater divide,

(ii) travel times from groundwater divide to both rivers ($n_e = 0.35$).

(8 marks)

- END OF QUESTIONS –

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FIGURE

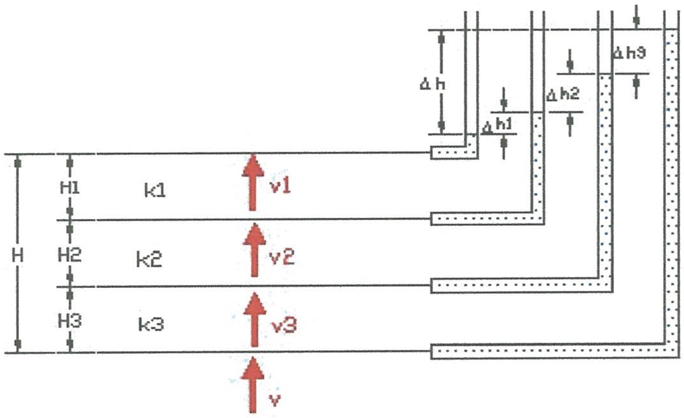

FIGURE Q3(c): Horizontal layer of flows

EQUATIONS

$$A = \frac{\pi D^2}{4} \qquad Q_s = -K_s \frac{dh}{ds} A$$

$$d = \frac{L}{2} - \frac{K}{W}\frac{\left(h_1^2 - h_2^2\right)}{2L}$$

$$h_{max}^2 = h_1^2 - \frac{\left(h_1^2 - h_2^2\right)d}{L} + \frac{W}{K}\left(L-d\right)d$$

$$V_a = \frac{K}{n_e}\frac{\Delta h}{\Delta x} \qquad t = \frac{L_A}{V_A} \qquad K_{eq} = \frac{\Sigma H}{\Sigma \frac{H}{K}}$$

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TABLES

Table Q3(d): Hydraulic conductivity values

Material	K (cm/sec)
Gravel	10^{-1} to 100
Clean sand	10^{-4} to 1
Silty sand	10^{-5} to 10^{-1}
Silt	10^{-7} to 10^{-3}
Glacial till	10^{-10} to 10^{-4}
Clay	10^{-10} to 10^{-6}

Table Q5(c): Pumping test

Step	Q (l/s)	s_w (m)	Q/s_w (m^2/day)
Rest	0	0	0
1	14.7	1.43	888
2	31.5	3.46	787
3	44.4	5.41	709
4	57.6	8.90	559