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Department of Environmental, Water & Earth Sciences

HYDROGEOLOGY I **TEST 2** **November 2021**

Surname:_____ Initials:_____

Student number:_____

Time allowed: 1.5 hours

QUESTION 1 2marks x 5 =10 marks

Write equations that relate the following parameters.

2.1 Darcy velocity and seepage velocity [2]

_____**vs =vd/n**_____

2.2 Pore pressure and intergranular forces [2]

____effective/total stress = intergranular forces – pore pressure _____

2.3 Volumetric discharge rate and Darcy velocity [2]

_____**vd = Q/A**_____

2.4 Gravity and specific weight [2]

_____**specific weight = density x gravity** _____

2.5 Volumetric discharge rate and hydraulic conductivity [2]

_____**Q=KiA**_____

QUESTION 2 [21 marks]

2.1 Write an equation that expresses Darcy's law in terms of the properties of the rock and the fluid. Define all the terms you use. [8]

$$v_d = \frac{Cd^2 \gamma A}{\mu} i$$

where v_d **is the Darcy velocity**

C **is the shape factor**

A **is the area of the cross-sectional area**

i **is the hydraulic gradient**

γ **is the specific weight of the fluid**

μ **is the viscosity of the fluid**

2.2 Write down an equation that relates hydraulic conductivity and intrinsic permeability [3]

$$K = K_i \left(\frac{\gamma}{\mu} \right)$$

where **K is the hydraulic conductivity**

K_i is the intrinsic permeability

γ **is the specific weight of the fluid**

μ **is the viscosity of the fluid**

2.3 A constant-head permeameter has a sample of medium-grained sand 20cm in length and 25cm^2 in cross-sectional area. With a head of 10cm, a total of 150ml of water is collected in 10 min.

2.3.1 Determine the hydraulic conductivity in cm/s and m/day. [5]

Use the relationship, K = (VL)/(ATΔh) = (150 x 20)/(25 x 10 x 10) =

2.3.2 If the experiment was carried out at a temperature 15˚C, determine the intrinsic permeability of the sample. [5]

Use the relationship $K = K_i\left(\frac{\gamma}{\mu}\right)$. Use the temperature to get the viscosity and the density. Calculate the specific weight using the density and acceleration due to gravity given. Make sure all your units are consistent i.e. the same.

QUESTION 3 [13 marks]

Groundwater flows through a buried-valley aquifer with a cross sectional area of $1x10^3$ m^2 and a length of $4x10^2$ m. Hydraulic heads at the ground-water entry and exit points in the aquifer are 1000 and 800m respectively. At the downstream end of the aquifer, groundwater discharges into a stream at a rate of $2.5x10^5$ m^3/day.

3.1 Determine the hydraulic conductivity of the buried-valley aquifer [6]

With the parameters given the best equation to use is Q = KiA so that K = Q/(iA)

3.2 Given that the porosity of the material is 0.2, determine the linear groundwater velocity? [3]

vs = vd/n

3.3 Determine the intrinsic permeability of the aquifer at 25^{o}C. [4]

Use the relationship $K = K_i\left(\frac{\gamma}{\mu}\right)$. Use the temperature to get the viscosity and the density. Calculate the specific weight using the density and acceleration due to gravity given. Make sure all your units are consistent i.e. the same.

QUESTION 4 [8 marks]

Describe the method that is used to measure hydraulic conductivity of a cohesive soil. Use diagrams to illustrate your answer [8]

The hydraulic conductivity of cohesive soils is determined using the falling head permeameter. In this apparatus relatively little water is passed through a sample over a typical time of several hours. The hydraulic conductivity is then calculated using the relationship:

$$K = \frac{d_t^2 L}{d_c^2 t} \ln\left(\frac{h_o}{h}\right)$$

where d_t is the internal diameter of the falling head tube, d_c is the diameter of the sample, h_o is the initial head of water in the falling head tube, h is the final head of water.