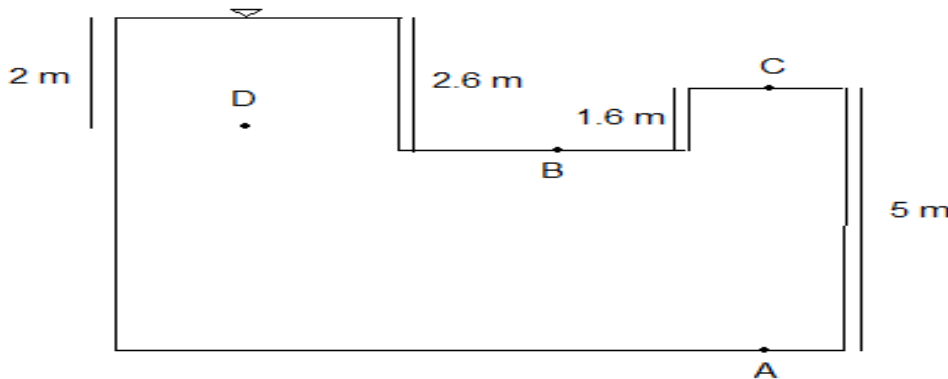


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Hydrogeology Homework Set 2 Darcy law

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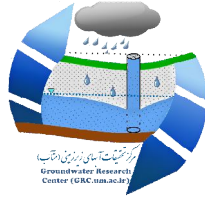
1. Calculate the pressure and total energy in fig below at A,B,C and D in pascal.



2. A fluid in aquifer is 4 meters above reference datum, the fluid pressure is 2400 N/m^2 and the flow velocity is 10^{-5} m/sec . fluid density is $1.01 \times 10^3 \text{ kg/m}^3$ and total volume is 10^7 cc .

- find total energy per unit mass.
- find total energy per unit weight.
- find total energy per unit volume.

3. A falling-head permeameter is set up to measure the K of a silty sample. the sample is a cylinder 10cm in diameter and 30cm long. the burette has a diameter of 5 mm. at the start of the test, the head difference across the sample is 90 cm. Assuming the samples k is equal with $2 \times 10^{-6} \text{ cm/sec}$, estimate how much time will elapse before the head difference across the sample reduce from 90 cm to 30 cm?



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4. Imagine isotropic homogeneous aquifer which consists of stones with intrinsic permeability of 8×10^{-5} darcy, calculate hydraulic conductivity of this aquifer if the density of aquifer material is 1 gr/cm^3 and viscosity of aquifer material is 0.01 gr/s.cm ?

5. An aquifer has three different formations. Formation A has a thickness of 30 feet and hydraulic conductivity of 7 feet per day. Formation B has a thickness of 15 feet and conductivity of 78 feet per day. Formation C has a thickness of 22 feet and a conductivity of 17 feet per day. Assume that each individual formation is isotropic and homogeneous. Compute both the overall horizontal and vertical conductivity?

6. Four horizontal, homogeneous geological formations, each 5 m thick, overlie one another. If the hydraulic conductivities are 10^{-4} , 10^{-6} , 10^{-4} , and 10^{-6} m/s, respectively calculate the horizontal and vertical components of hydraulic conductivity for the equivalent homogeneous but anisotropic formation. A: Calculate the anisotropic ratio which is defined as the average horizontal over the average vertical hydraulic conductivity.

(b) Repeat for hydraulic conductivities of 10^{-4} , 10^{-8} , 10^{-4} , and 10^{-8} m/s, respectively. Calculate the anisotropic ratios for these two cases.

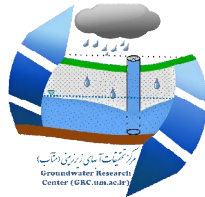
7. Is Darcy law valid in an aquifer which consists of coarse sand with the width of 1 km where the average pore diameter is 0.05 cm, $k: 0.25 \text{ cm/sec}$, $n: 0.4$, and hydraulic gradient is 0.01? How long does it take for a tracer to pass through the width of this aquifer?

8. A confined aquifer is 10 feet thick. The piezometric surface drops 0.54 feet between two wells that have 792 feet distance. The hydraulic conductivity is 21 feet per day and effective porosity is 0.17.

a. How much water in cubic feet per day is moving through a strip of the aquifer that is 10 feet wide?

b. What is the average linear velocity?

9. Suppose a one-dimensional confined aquifer, which consists of 4 parts with different $K: k_1: 2 \times 10^{-4}$, $k_2: 4 \times 10^{-4}$, $k_3: 1 \times 10^{-3}$ and $k_4: 5 \times 10^{-4}$ m/s. Hydraulic head (h) is held constant at both boundaries of the aquifer. The system is in a steady state.



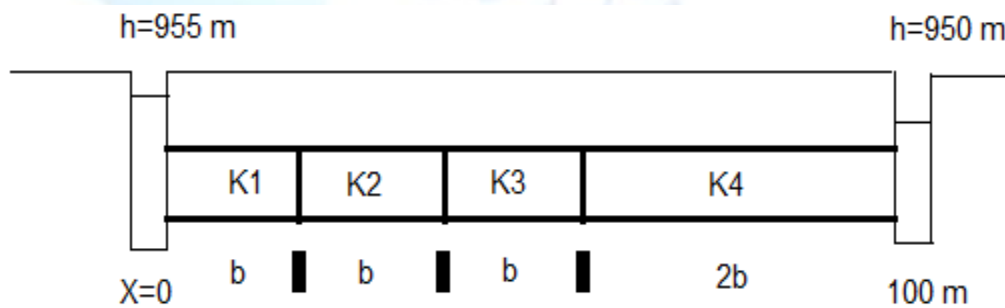
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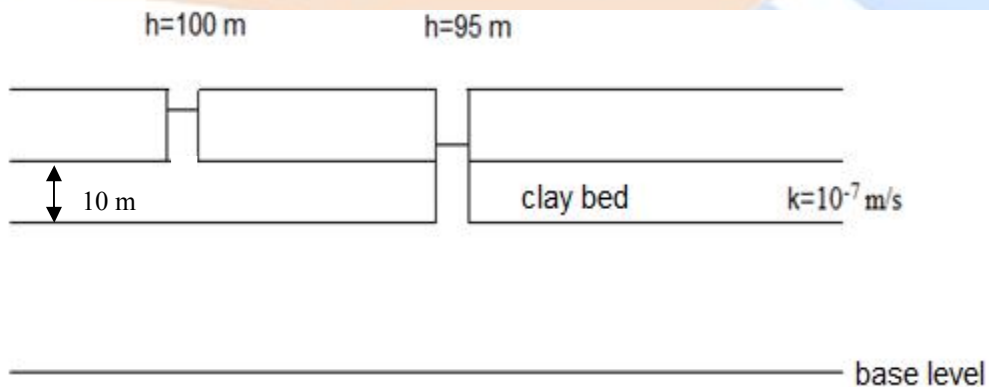
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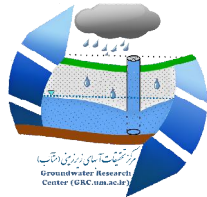
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- a) Calculate the horizontal hydraulic conductivity of the aquifer.
- b) Calculate the specific discharge in the aquifer.
- c) Note that k is constant throughout the aquifer, which means $K \times dh/dl$ must be constant throughout the aquifer. Calculate head drop in each section.



10. How much is darcy flux in clay bed per m/s in below figure?





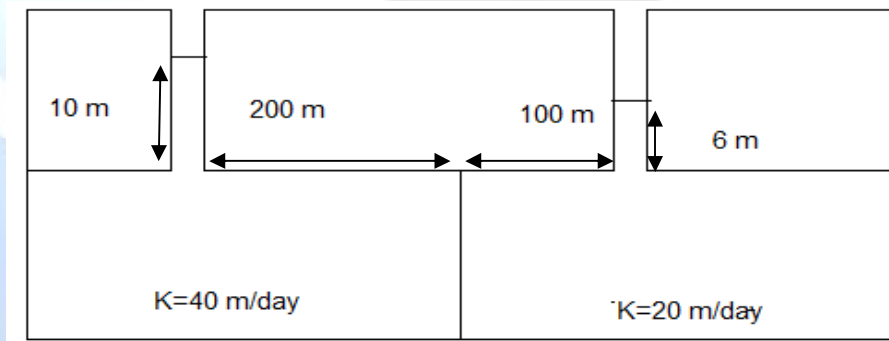
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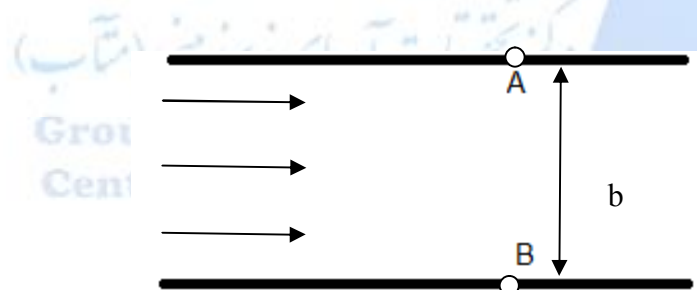
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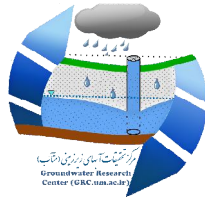
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11. How much discharge in below figure in unit width per unit m^3 /day?(the thickness of confined aquifer is 20 m)



12. What difference of hydraulic head in 2 point A and B In confined aquifer that showing in below figure?





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13. Imagining that culvert under road has become packed with sand from end to end as a result of storm. The culvert is 5 m long and 0.8 m diameter. The sand in it is estimated to have hydraulic conductivity 3 m/day and effective porosity of 0.38. The water level at one end of culvert is 1.6 m higher than at the other end, and the entire of the culvert is below the water.

calculate the discharge and average linear velocity through the culvert?

14. An unconfident aquifer has hydraulic conductivity of 1.7×10^{-3} cm/sec. There are two observational wells with 328 feet distance. Both of them are full penetrate. In one observational well the water stands 24.6 feet above the bottom and in other one it is 20 feet above the bottom.

- a) What is discharge per 100 foot wide strip of the aquifer in feet³/day?
- b) What is the water table elevation at a point midway between the two observational wells?

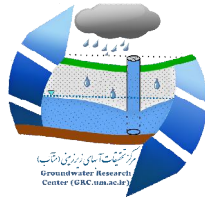
15. In a confined aquifer, the pontiometer surface drops 20 cm per 1 km and has a transmissivity of 80m²/day.

What is the discharge per 1 km wide strip of the aquifer in m³/days.

16. The following field notes were taken at a nest of piezometers installed side by side at a single site.

Piezometer	A	B	C
Evelation at surface	370	370	370
Depth of piezometer	250	75	165
Depth to water table	67	62.5	64.5

- a) What is the groundwater flow direction? why?
- c) Calculate the hydraulic head, pressure and elevation head at A,B,C per meter?



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17. The following figure show vertical pair of piezometer located under the undeveloped area south of SAROUGH in Sabzevar.

- Assuming that the flow is steady state and $K: 2 \times 10^{-7} \text{ m/sec}$, estimate groundwater velocity and its direction.
- Calculate the real velocity in case of n equal with 0.3. Why real velocity and darcy velocity difference?

