

DARCY'S LAWS OF PERMEABILITY.

Purpose

To determine the relationship between the hydraulic gradient, the length of the aquifer, cross sectional area of the aquifer and the quantity of water passing through the aquifer.

Activity

- 1. Record the diameter and length of the horizontal tube.*
- 2. Saturate the sand until water is coming from the horizontal end by pouring water into the vertical tube*
- 3. Fill the vertical tube with distilled water until it is just above the 25cm mark.*
- 4. When the water has reached the 25cm mark place the measuring cylinder under the right hand end and start the timer and keep the level of the water constant by occasionally adding more.*
- 5. Remove the measuring cylinder after five minutes.*
- 6. Now add more water so that the water level is 50cm*
- 7. Repeat instructions 1 to 4 with the water at 75cm and 100cm.*
- 8. Now repeat the same instructions for tubes with different diameters and different lengths or obtain the data from other students. Calculate the hydraulic gradient.*
- 9. Plot three graphs:
a graph of volume of water against tube length and
a graph of volume of water against cross sectional area
a graph of volume of water against head (height of water in vertical tube)*
- 10 From this information try to derive an equation which relates water volume to cross sectional area, length and water pressure.*

Teacher's Section

Requirements

The apparatus described below.

2 Funnels and a jug

100mm measuring cylinder

Distilled water with a little bleach added

Bowl or beaker to catch water when not being measured

Small G clamp to hold apparatus to table

Wash bottle (useful for keeping water up to required level)

Making the equipment (two hours)

You will need: Clear polythene tube. 2.05m of 3cm and of 1.5cm diameter tube. 6.70m of 2.5cm diameter tube.

Elbows (right angled junctions). 2 each to fit 3cm and 1.5cm tubes and 8 to fit 2.5cm diameter tubes.

6 boards 1.1m long and 5cm wide marked at 25cm, 50cm, 75cm and 100cm from one end.

Sealant

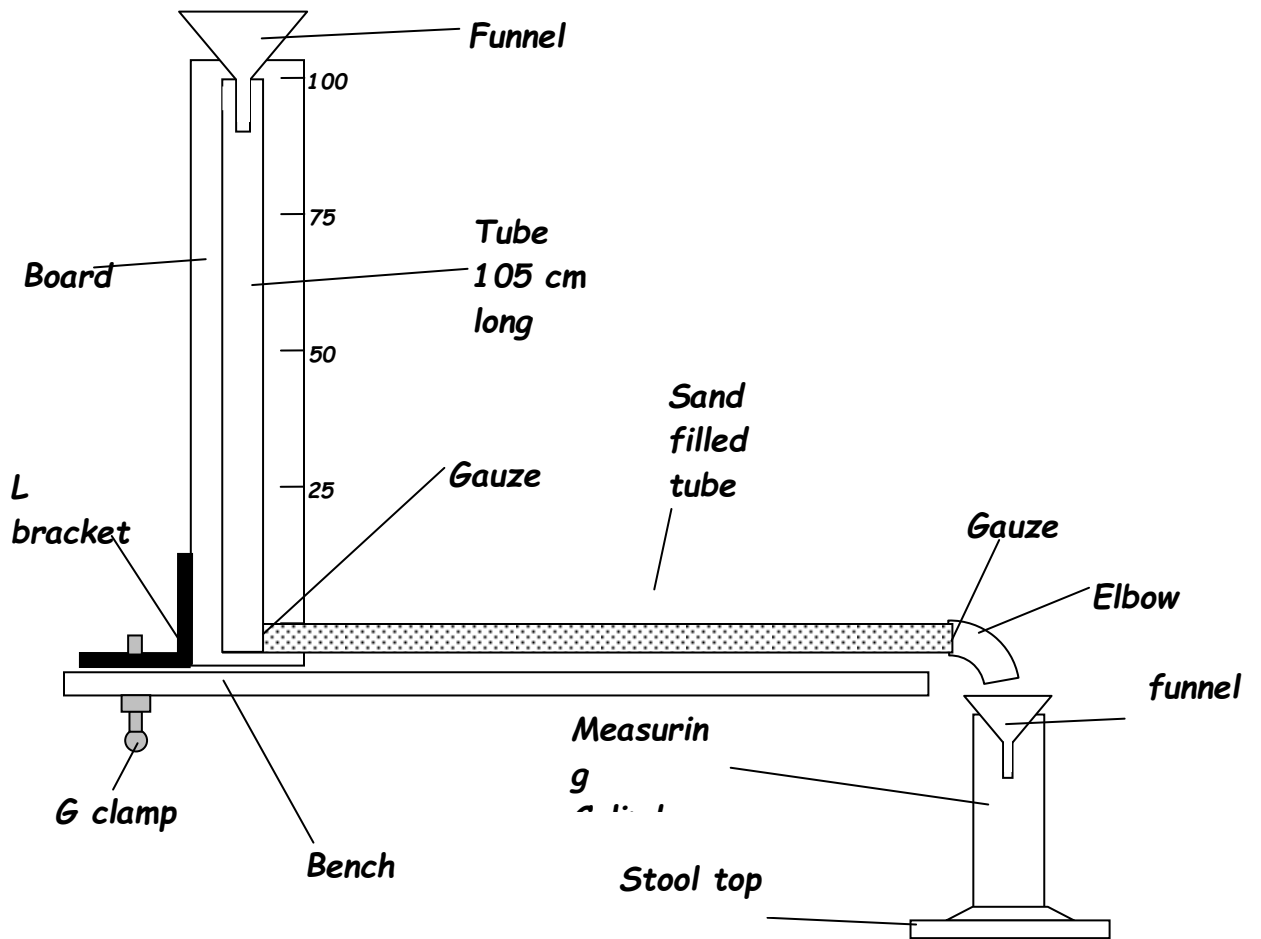
Sand 0.25mm

6 L shaped brackets

Gauze. 12 pieces about 6cm square

Take the following pieces of tube and fix an elbow on the end with gauze between the elbow and the tube.

100cm lengths of 3cm, 2.5cm and 1.5cm diameter tube. 75cm, 50cm and 25cm lengths of 2.5cm diameter tube. When the sealant has set fill the tubes with sand and shake them to compact the sand. Make sure each tube is completely full. Use sealant to glue gauze and another elbow on the other end of each tube. Use sealant to fix a 105cm length of tubing to one elbow on each tube. Take the board and screw an L shaped bracket to the zero end. Attach the 105cm tube to the board using clips. The diagram shows how it should be mounted on the bench. It will take about 2 hours to make.



Notes

There is likely to be some spilt water. This activity works best if pairs of students do one tube each and then share results using a table like this.

diameter	length	volume of water in 5 minutes			
		25cm head	50cm head	75cm head	100cm head
3.0cm	100cm				
2.5cm	25cm				
2.5cm	50cm				
2.5cm	75cm				
2.5cm	100cm				
1.5cm	100cm				

To save time the water should be poured in before hand so that it has time to soak the sand.

Results

The volume of water (V) increases with diameter (d) and head (h) but decreases with length (L) of tubing. $V = \frac{k \times d \times h}{L}$

(k = coefficient of permeability, a constant for a given sand)

Cost

Tubing and connectors cost £20

Time

45 minutes to do one tube (4 readings)