FLOW OF WATER AND OIL

The purpose of these five experiments is to demonstrate the effects of grain size, sorting, length, cross sectional area, pressure and temperature on the flow of water or oil through an aquifer or reservoir bed.

Activity I To determine if the **grain size** of well sorted sand affects its permeability.

1. Record the grain size and the thickness of sediment in the tube. All the tubes contain well sorted sand.

2. Fill the tube containing the finest sediment up to about 2cm above the top line with distilled water. Start the timer as soon as the water reaches the top line. Measure the time it takes for the top of the water to fall to the top of the sediment.

3. Do the same for the other tubes.

4. Empty water from tray below tubes.

5. Plot and explain your results.

Activity II To determine the relationship between **sorting** and permeability in sand.

1. Note the degree of sorting of the sediment in the first tube.

2. Fill the tube with water to about 2cm above the top line. Start the timer when the top of the water reaches the top line. Measure the time it takes for the water to fall to the top of the sediment.

3. Repeat for the other tube.

4. Empty water from the tray beneath the tubes.

5. Explain your results.

Activity IIIa To show the relationship of sediment **length** to speed of flow.

1. Measure the length of sediment in a tube.

2. Pour 50ml of water quickly into the tube and record the length of time it takes for the top of the water to sink to the top of the sediment.

3. Follow instructions 1 and 2 for the other tubes.

4 Plot length against time.

Activity IIIb To show how water **pressure** affects speed of flow.

1. Quickly pour 25ml water into the tube with the least sediment in it. Record the time it takes for the top of the water to reach the top of the sediment.

2. Explain why it takes more than half as long as 50ml.

Activity IV To determine the relationship between **cross-sectional area** and volume of transmission and speed of transmission.

1. Fill the largest tube up to the about 2cm above the 20cm mark. Start the stop watch when the top of the water reaches the 20cm mark and stop it when the top of the water reaches the top of the sediment.

2. Fill the same tube up again but this time as soon as the water reaches the 20cm mark place a cup under the tube and start the stop watch. Remove the cup after 1 minute and measure the volume of water in it.

3. Do the same for the other tubes but this time you can do both 1 and 2 together. Record your results in a table like this.

Diameter	Area	Time	Volume in 1 minute
35mm	962 sq mm		
25mm	490 sq mm		
15mm	176 sq mm		
10mm	78 sq mm		

4. Plot area of cross section against volume collected in the cup. Explain your results.

Activity V To show how the **temperature** of water affects the speed at which it will flow through sediments.

1 Pour about 50ml of ice cold water through the sand to make sure the sand is at the same temperature as the water.
2 Now place a small beaker under the tube and then pour in more ice cold water until the water is 2cm above the top line making sure no ice is poured in. Start the timer when the water level has reached the line.
3 Record the time for the top of the water to reach the top of the sediment.
4 Record the temperature of the water in the beaker after it has flowed through.
5 Repeat instructions 1 to 4 for hot water and warm water
6 For each calculate the average temperature of the water flowing through and then plot temperature against time.

Permeability apparatus

Teacher's Section

Requirements

Each activity needs a rack of tubes as described in Making equipment and below.
Mark each tube 20cm above base.
Distilled water
All activities need a timer and a funnel
Tray below tubes to collect water

Requirements for grain size

4 tubes about 2.5cm internal diameter filled with 10cm of well sorted sand of the following grain sizes: 0.25 to 0.5mm, 0.5 to 1.0mm, 1.0 to 2.0mm, 2.0 to 4.0mm. The grain size should be marked above each tube. If you do not have sieves remember it is not necessary to have the exact sizes quoted. The important thing is to have a range of grain sizes.

Requirements for sorting

2 tubes about 2.5cm internal diameter filled with 10cm of sediment. One tube should contain well sorted sediment whereas the other should contain poorly sorted sediment but with the same median grain size.

Requirements for thickness

3 tubes about 2.5cm internal diameter all filled with the same sized sediment but to different thicknesses. If sand with a grain size between 0.25 and 0.5mm is used then the following thicknesses are suitable: 2.5cm, 5cm, 10cm.
100ml measuring cylinders or clear plastic cups marked at correct level.

Requirements for area of cross section

Four tubes with varying internal diameters; 10mm, 15mm, 25mm and 35mm are suitable. Each tube should be filled with the same sediment, if sand between 0.25 and 0.5mm is used then a 10cm thickness is suitable.
Plastic cup and measuring cylinder.

Requirements for temperature

3 tubes 30cm long and 2.5cm internal diameter are satisfactory. Each should be filled to a depth of 10cm with sand about 0.25mm but probably any sand and any tube would work so long as it does not take too long to flow through. Use one tube for each temperature.

Hot water, about 50°C; water at room temperature, ice-cold water

Results

The coarser the grain size the faster the flow. Fluids flow through well sorted sand faster than poorly sorted sand. The greater the length (thickness) the water has to flow through the slower it will flow. Pressure (including head of water) increases rate of flow, as does increased cross sectional area. In activity IV the water level should go down at the same speed in each tube.

Increasing the temperature lowers the viscosity and therefore increases speed of flow.

Notes

Use distilled water otherwise the sediment clogs up.

Time

About 30 minutes for each activity.