

**Groundwater**

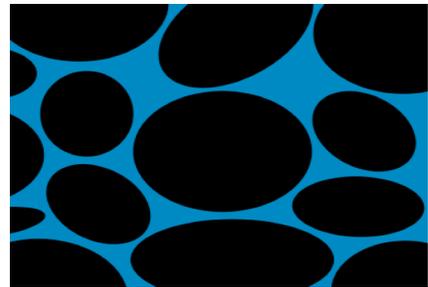
Groundwater is water below the Earth’s surface that is located in pore spaces between mineral grains and fractures in rocks and is an important source of fresh water in the U.S. There are 3 factors that determine whether a source of groundwater will be a viable resource:

- quantity
- ease of withdrawal
- water quality

An aquifer is a rock or sediment layer that contains groundwater and has sufficient *porosity* and *permeability* that the water can be extracted (such as with a well). *Aquitards* are low-permeability materials such as clay, shale, or unfractured igneous or metamorphic rock, that act as a barrier to water flow.

**Porosity**

*Porosity* is the proportion of a material that is made up of pore spaces. Different geologic materials have a wide range of porosities and the availability of groundwater is controlled by porosity of the rock or sediment.



**Porosity Experiment**

To better understand how porosity varies for different materials, you will determine the porosity of sand and gravel and a sand-gravel mixture.

1. Obtain the following materials:  
 Three cups or beakers  
 100 ml of fine sand  
 100 ml of gravel  
 100 ml of a sand and gravel mixture  
 graduated cylinder

2. Place each sample into a different beaker.
3. Using the graduated cylinder, measure the amount of water (in ml) that you can pour into each sample just to the top of the sample. If bubbles form in the sample, you can gently tap the beaker on the tabletop to remove it. Repeat for each sample and record your data in the table

Material	Amount of sediment	Amount of water	%porosity
Sand	100 ml		
Gravel	100 ml		
Mixture	100 ml		

4. Determine the %porosity for each sample where  

$$\%porosity = (\text{amount of water}/100 \text{ ml}) \times 100\%$$

**Questions.**

Which material had the greatest porosity?

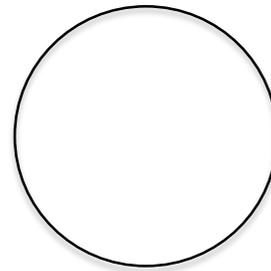
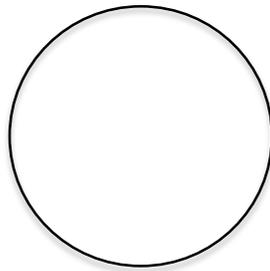
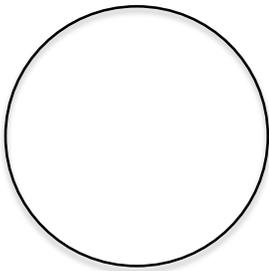
Which material had the lowest porosity? Why do you think the porosity was so low?

Draw the sediment and pore space for the 3 materials in the circles below

Gravel

Sand

Mixture



**Permeability**

*Permeability* is the capacity of water to flow through earth materials. Water can flow readily through materials with well connected pore spaces or many fractures. In this experiment, you will measure the permeability of various geologic materials and how permeability may affect groundwater flow.



**Permeability Experiment**

1. Obtain the following materials:
  - graduated measuring cylinder
  - beaker
  - 3 small funnels
  - cotton
  - samples of gravel, sand and soil
  - timer
2. Place a small piece of cotton in the neck of the funnel. Be careful not to insert it too tightly so that it will restrict flow.
3. Fill the funnel above the cotton about two-thirds full with gravel.

4. With the bottom of the funnel placed inside the beaker, measure the length of time that it takes for 50 ml of water to drain through each funnel. Be sure to quickly pour the entire contents of the graduated cylinder into the funnel. Record the time in the data table.

	Time to drain 50 ml of through funnel	Amount of water (ml) drained into the beaker
Gravel		
Sand		
Soil		

5. Using the measuring cylinder, measure the amount of water that has drained into the beaker and record the measurement in the data table.

6. Repeat the experiment for each material. Be sure to duplicate the conditions of the first experiment by using the same size piece of cotton, placement of the cotton and filling the funnel with the same amount of material. Record your results in the data table.

**Questions**

1. Of the 3 materials (gravel, sand and soil), which has the greatest permeability?
2. Suggest a reason why different amounts of water were recovered in the beaker from each experiment.
3. Predict which material you think would be the best aquifer. Explain your reasoning.
4. Write a summary of your permeability experiment, summarizing your data and results.