**Permeability Lab**

**Roles:**

**Materials Collector = collects all materials needed for the lab and cleans them at the end**

**Data Recorder/Timer = write down information to share with group when lab is completed/in charge of stopwatch**

**Procedure Reader = reads procedure and instructs group members what they should do**

**Experimenter = takes instruction from the Procedure Reader and conducts the experiment**

**Background: (answer questions in lab notebook – use PQIA!)**

1. What is permeability?
2. What does it mean for an aquifer to “recharge”?
3. What is a substrate?

Read the information below to help you answer the questions above.

How does water move through materials such as rocks? Permeability is the measure of how easily water can flow through a material (like rocks, soil, clay or sand). People all over the Chicagoland area get their drinking water from the Cambrian-Ordovician Aquifer (COA).

We pump water out of the Cambrian-Ordovician Aquifer (COA) to use for drinking water, household uses, irrigation and commercial uses. The Cambrian-Ordovician Aquifer recharges from surface water and precipitation in the area. Water in the aquifer is replenished during recharge events (when water filters down into the underground rock layer – changing from surface water to ground water). Recharge adds water to the groundwater system when rainfall, melting snow, surface water or water from a creek or lake soaks in through the soil and rocks.

The material present at the surface, called a substrate, can influence how easily water can pass into the groundwater system. In this lab we examine permeability (how easily water can pass through a material) and porosity(how much water a material can store) of substrates found in the Chicagoland area.

**Question:**

Which substrate (soil, sand or rock) has the highest permeability? Why?

**Variables: (Hint: read procedure to help you identify the variables!)**

Independent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Controls (at least 2): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Hypothesis:**

If (independent variable)

Then (dependent variable)

Because (reason)

**Procedure:**

1. Measure 200mL of gravel in a beaker
2. Measure 200mL of water in a beaker. Add a few drops of food coloring to the water and stir
3. Stand the plastic bottle up in the sieve, holding it over the beaker with the top pressed firmly against the sieve (see picture)



1. Add gravel to the plastic bottle
2. Prepare to measure the amount of time it takes to drain the water through the sediment and into the beaker
3. Begin timing when the water is poured into the gravel. Pour all at once, but gently!
4. Stop timing when 100mL has drained into the beaker. WAIT for the rest to drain before cleaning it up.
5. Record this time (IN SECONDS) in your chart under “Trial 1”
6. Record any additional observations you make as the water filters.
7. Repeat for sand and soil.
8. Clean up all supplies, put them back in bin, put bin away, wipe down table
9. Share data with other tables (your Trial 1 will be someone else’s Trial 2 or 3. You will fill in your table for Trial 2 & 3 with the other groups’ information from Trial 1)

**Data Table:**

(Create this table in your notes)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Time 🡪 | **Observations** | **Trial 1**  **(in seconds)** | **Trial 2**  **(in seconds)** | **Trial 3**  **(in seconds)** | **Average**  **(in seconds)** |
| SAND |  |  |  |  |  |
| ROCK |  |  |  |  |  |
| SOIL |  |  |  |  |  |

**Technical Drawings:**

Draw what you saw happen in the lab – be sure to label the lab equipment, liquids, etc. ADD COLOR! (use colored pencils)

**Conclusion:**

No conclusion yet…you will write a combo conclusion for this lab and the porosity lab we will do this week.

**One more thing!**

\*\* Cut and paste the “Permeability Lab Sheet” into your notebook. Complete this page!

**Porosity Lab**

**Roles:**

**Materials Collector = responsible for collecting and returning all lab materials**

**Data Recorder = write down information to share with group when lab is completed**

**Procedure Reader = responsible for carefully reading procedure to group and making sure that everyone is doing the experiment correctly!**

**Experimenter = takes instruction from the Procedure Reader and performs the experiment (with the help of other group members)**

**\*\*If in a 3-person group, 1 person may have 2 roles\*\***

**Background: (answer questions in lab notebook – use PQIA!)**

1. What is porosity?
2. How do we measure porosity?

How much water can a material hold? Porosity is the measure of the void spaces in a material such as soil, sand or rock. Porosity is measured as a percentage of open space or pores in a material and can be calculated using a simple formula.

An aquifer is an underground layer of rock that stores water. The amount of water that the aquifer can store is directly related to its porosity. The substrates (sand, rock and soil) in this lab represent the aquifers.

**Question:**

Which substrate (sand, rock or soil) has the highest porosity? Why?

**Variables: (Hint: read procedure to help you identify the variables!)**

Independent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Controls (at least 2): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Hypothesis:**

If (independent variable)

Then (dependent variable)

Because (reason)

**Procedure:**

1. Fill each plastic cup with one of the following: 75 mL sand, 75 mL rock, 75 mL soil. “Knock” it on the table so that you have an even layer on the top.
2. Fill your graduated cylinder with 100 mL of water (you will refill your cylinder for each substrate).
3. Record 100 mL in your data table as your START volume.
4. ***Slowly*** pour the water from the cylinder into one of the substrates in the plastic cups until there is a very THIN layer of water covering the substrate. Begin with sand.
5. Read the remaining volume of water in the cylinder and record the volume as the FINISH volume in your data table.
6. Repeat steps 2-5 for each of the substrates
7. Complete the calculations

**Data Table:** (create this table in your notebook! ***Include the equations below***)

**PORE SPACE VOLUME = Start Volume – Finish Volume**

**% POROSITY = (Pore Space Volume / Substrate Volume) x 100**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | START VOLUME | FINISH VOLUME | PORE SPACE VOLUME | SUBSTRATE VOLUME | % POROSITY |
| SAND | 100 mL |  |  | 75 mL |  |
| ROCK | 100 mL |  |  | 75 mL |  |
| SOIL | 100 mL |  |  | 75 mL |  |

\*Pore space volume is how much water can fit in the pores of the substrate…the more water it can hold, the higher its porosity!

**Technical Drawings:**

Draw what you saw happen in the lab – be sure to ***label the lab equipment, liquids, etc. ADD COLOR!*** (Use colored pencils)

**Conclusion:**

Use the CONCLUSION FORMAT in your notebook. Be sure to discuss ALL parts of both the PERMEABILITY AND POROSITY labs AND connect it to the real world. Use the sample and the format questions to help guide you.

Be sure to discuss the following in your conclusion as well:

* List the substrates in order of lowest porosity to highest porosity.
* List the substrates in order of lowest to highest permeability.
* Combining what you learned from both labs, which material would make a good filter? Why?
* Which material would make a good aquifer? Why?

**One more thing!**

\*\* Cut and paste the “Porosity Lab Sheet” into your notebook. Complete this page!