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| **Lesson Title : The Hydrologic Cycle** | **Unit #:****1** | **Lesson #:****1** | **Activity #:****2** |
| **Activity Title: Soil Porosity and Permeability** |

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| **Estimated Lesson Duration:** | **2 Class Periods** |
| **Estimated Activity Duration:** | **1 Class Period** |

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| **Setting:** | **Classroom** |

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| **Activity Objectives:** |

Describe how the terms porosity and permeability are related.

Calculate the porosity and permeability of different types of soil.

Describe how porosity and permeability are a natural method to clean water.

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| **Activity Guiding Questions:** |

How does surface water get into the ground?

How does water move through different types of soils?

| **Next Generation Science Standards (NGSS)**  |
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| **Science and Engineering Practices (Check all that apply)**  | **Crosscutting Concepts (Check all that apply)** |
| ☐ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☒ Developing and using models | ☒ Cause and effect |
| ☐ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☒ Systems and system models |
| ☒ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function.  |
| ☐ Engaging in argument from evidence | ☐ Stability and change.  |
| ☒ Obtaining, evaluating, and communicating information  |  |

| **Ohio’s Learning Standards for Science (OLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☒ Demonstrating Science Knowledge **(D)** |
| ☐ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Ohio’s Learning Standards for Math (OLS) and/or** **Common Core State Standards -- Mathematics (CCSS)** |
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| **Standards for Mathematical Practice (Check all that apply)** |
| ☐ Make sense of problems and persevere in solving them | ☐x Useappropriate tools strategically |
| ☐x Reason abstractly and quantitatively | ☐ xAttendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, OLS and/or CCSS):** |

Develop and use models

Analyze and interpret data

Biogeochemical cycles

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

**Materials (per group)**

2 large cups (one with hole in the bottom) Graduated Cylinder

Marker 500 ml Beaker

Timer

Calculator

Spoon or Scraper

Water

Pea gravel

Sand

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| **Teacher Advance Preparation:** |

* Set up materials for each student workstation
* Make copies of the lab worksheets

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| **Activity Procedures:** |

* Introduce the key terms and review the directions for the lab assignment.
* Complete sample problem on how to do the calculation for porosity.

**Procedure for measuring porosity**

1. Measure out 100 ml of water in the graduated cylinder
2. Pour the 100 ml of water in one of the cups and use the marker to mark the level
3. Pour the water back into the graduated cylinder
4. Fill the same cup with sand up the mark you drew
5. Pour the 100 ml of water slowly into the sand. Stop when the water level just reaches the top of the sand.
6. Record the amount of water left in the graduated cylinder in the right column.
7. Calculate the pore space by subtracting the amount left in the graduated cylinder from the original 100 ml.
8. Repeat steps 4-7 with the pea gravel, yard soil, and clay.
9. Calculate the %porosity and record in the table. Use this formula:

Porosity = Pore Space Volume x 100

 Total volume

**Procedure for measuring permeability**

1. Place the same amount of sand in the cup with a hole in the bottom.
2. Get the timer ready. Hold the cup over a beaker to catch the water.
3. Pour the entire 100 ml of water quickly into the cup of sand. Start recording as soon as the water hits the sand.
4. Stop the timing as soon as the first drop of water comes out of the hole in the bottom.
5. Repeat steps 1-5 with the pea gravel.

\*Be careful when adding the water to the clay.

**Formative Assessments: Review answers to lab questions.**

**Summative Assessments: Summative assessment will include questions regarding porosity and permeability.**

The porosity and permeability worksheet will be graded for a summative assessment.

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| **Differentiation:** Work with students to calculate porosity using the given formula. Answer end of the lab questions independently and review working in small groups to ensure understanding. |

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| **Reflection:** It was difficult for some students to calculate permeability. To address this issue, students were encouraged to get the data and we worked as a group to calculate the values. It was unclear to some groups when to “stop” pouring the water when gathering data for permeability. Some groups continued pouring water beyond the optimal “stop” point because they were pouring too fast and they had “extra” water included in their calculation. Overall, the lab provided a good visual for porosity and permeability. It was obvious which soils had greater and porosity and permeability even if it was not quantified correctly.  |