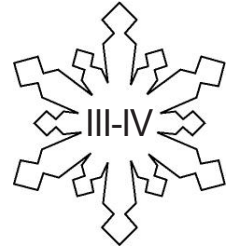


# Soil Permeability

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Levels



Grades 5-8

## Overview:

Permeability of the soil is affected by environmental conditions. In this lesson, students explore how soil permeability is affected by the presence of permafrost and discuss how this might affect vegetation.

NOTE: This lesson will require more than one class period as it requires freezing overnight. Students should have a basic understanding of permafrost before this lesson.

## Objectives:

The student will:

- conduct an experiment;
- explain how permafrost affects soil permeability; and
- explain how permafrost thaw affects vegetation.

## GLEs Addressed:

*Science*

- [5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [5] SA3.1 The student demonstrates an understanding that interactions with the environment provide an opportunity for understanding scientific concepts by identifying the limiting factors (e.g., weather, human influence, species interactions) that determine which plants and/or animals survive.
- [8] SD1.2 The student demonstrates an understanding of geochemical cycles by applying knowledge of the water cycle to explain changes in the Earth's surface.

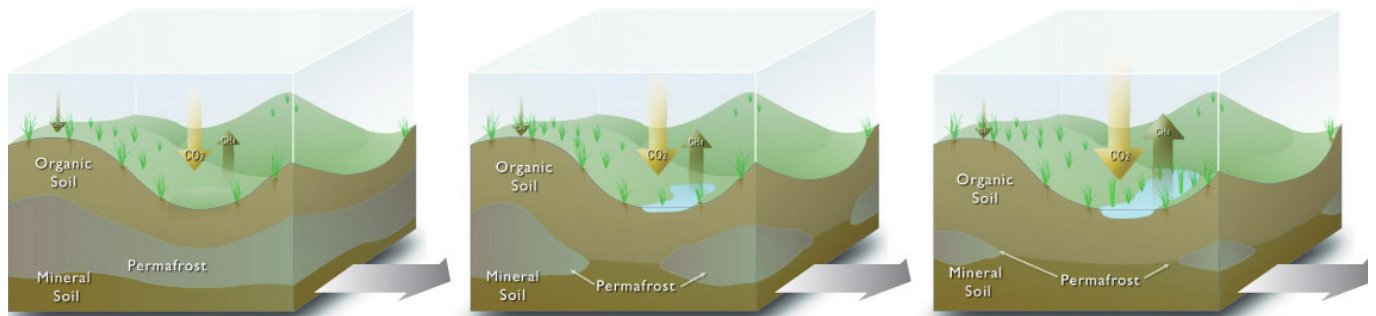
## Materials:

- Fine soil, packaged and sterile (one coffee can full per group)
- Heavy stock plastic transparency sheets (two per group)
- Clear packing tape
- Food coloring
- Beakers, 200-milliliter or larger (two per group)
- Water
- Scissors
- Skewers (two per group)
- 200-milliliter graduated cylinder (one per group)
- Nylon socks, for screen (two per group)
- Ring stands (two per group)
- STUDENT WORKSHEET: "Soil Permeability Experiment"

## Whole Picture:

The amount of water held in the soil depends on the permeability of the soil, which is determined by the size of the soil pores. Different plants require varying amounts of water. Some plants, such as cacti, thrive in sandy soils; other plants, such as some ivy, do better in a loam. Changes in permafrost can affect the water content of soils in permafrost areas, resulting in changes to plant life.

Permafrost thaw affects water drainage. Permafrost (frozen ground) traps rain water and snow melt at the surface of the ground, preventing drainage by reducing permeability. As the active layer becomes deeper and permafrost degrades, depressions are created in the ground where more water can be retained at the surface, altering the landscape. However, as permafrost continues to thaw, much of this moisture can be lost as permeability of the soil increases and water drains into the soil. Drainage of lakes can eventually eliminate the aquatic habitat in those areas.



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## Activity Procedure:

1. Ask students how permafrost might affect water drainage. List student responses on the board. Explain soil is typically permeable; it has air spaces that allow liquids and gases to pass through. When soil becomes frozen, that permeability decreases and less water can travel through. In the spring, melted snow often forms small ponds on the surface of the ground. This is because the permeability of the soil is low due to freezing and other environmental conditions. When the soil thaws, the water permeates, or sinks, down into the soil.
2. Discuss the terms permeability and percolation; make sure students understand that they represent similar concepts. Percolation is the act of a liquid moving through a material; permeability is the quality of a material that allows liquid to percolate (or move through it).

### **Beginning the Experiment**

3. Tell students they will perform an experiment to demonstrate soil permeability. Divide students into small groups. Explain students will be making two soil columns.
4. Demonstrate how to make a soil column by completing the following steps:
  - STEP 1. Roll two sheets of clear plastic transparencies into two cylinders to make two columns. Each cylinder should have a diameter of about 2 inches. Use clear plastic tape to secure the shape.
  - STEP 2. Cut pieces of the nylon sock into small squares large enough to cover the bottom of the soil columns. Before attaching, poke several large holes into the nylon, so it will not affect the percolation of the soil columns. Attach the nylon with tape to the bottom of the soil columns.
  - STEP 3. Fill both cylinders completely full with the soil. Pack the soil as firmly as possible without damaging the plastic containers.

5. Explain one soil column will be frozen and one will remain non-frozen. The non-frozen column will serve as the control. Ask students to name the variable in the experiment. (*frozen water in the soil column*)
6. Ask students to form a hypothesis to explain what will happen to permeability when water is applied to the frozen column of soil. Explain this hypothesis must be testable. Distribute the STUDENT WORKSHEET: "Soil Permeability Experiment." Instruct students to write their hypothesis on their worksheets.
7. Distribute materials (as indicated on the student worksheet) to each group and instruct groups to create their soil columns by following the procedures on their student worksheets. Place soil columns in the freezer overnight.

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**Teacher's Note:** Make sure the soil is not too dry before freezing. If the soil is too dry before it is frozen, water added after freezing may be absorbed by the soil column.

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### Continuing the Experiment

8. Retrieve frozen soil columns from the freezer and instruct students to complete their experiment and their student worksheets.
9. Discuss student results and answers to questions 5-7 on the worksheet.

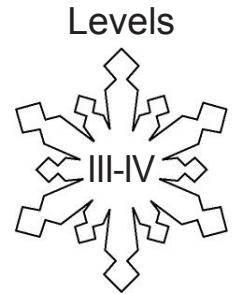
### Answers:

1. Answers will vary.
2. Answers will vary but should demonstrate more water percolating through the non-frozen soil. Neither amount should be more than 150 milliliters.
3. Non-frozen
4. Answers will vary.
5. Answers will vary but should demonstrate an understanding of a valid experiment (multiple trials, use of control, single variable, etc.).
6. Answers will vary.
7. A. The plants may drown from too much water. Surface water will be trapped, creating ponds or marshes.  
B. Plants may not have enough water, because ponds and lakes might drain.

Name: \_\_\_\_\_

# Soil Permeability Experiment

## Student Worksheet (page 1 of 5)



### Background Information:

Soil is typically permeable; it has air spaces that allow liquids and gases to pass through. When soil becomes frozen, that permeability decreases and less water can travel through. In the spring, melted snow often forms small ponds on the surface of the ground. This is because the permeability of the soil is low due to freezing and other environmental conditions. When the soil thaws, the water permeates, or sinks down into the soil.

### Testable Question:

What will happen to permeability when water is added to a frozen column of soil?

### Hypothesis:

Write a hypothesis in answer to the testable question.

1. When water is added to a frozen column of soil, then permeability will be \_\_\_\_\_ (lower/higher) than a non-frozen column of soil.

### Experiment:

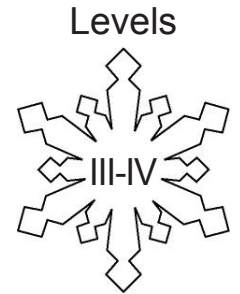
#### Materials:

- Fine soil
- 2 heavy stock plastic transparency sheets
- Clear packing tape
- Food coloring
- 2 beakers, 200-milliliter or larger
- Water
- Scissors
- 2 skewers
- 200-milliliter graduated cylinder
- 2 nylon socks, for screen
- 2 ring stands

Name: \_\_\_\_\_

# Soil Permeability Experiment

## Student Worksheet (page 2 of 5)



### Procedure:

#### Day 1

- STEP 1.** Roll two sheets of clear plastic transparencies into two cylinders. Each cylinder should have a diameter of about 2 inches. Use clear plastic tape to secure the shape.
- STEP 2.** Cut pieces of the nylon sock into small squares large enough to cover the bottom of each soil column. Before attaching, poke several large holes into the nylon, so it will not affect the percolation of the soil columns. Attach the nylon with tape to the bottom of the soil columns.
- STEP 3.** Fill both cylinders completely full with the soil. Pack the soil as firmly as possible without damaging the plastic containers. One of the cylinders will be the control in the experiment.
- STEP 4.** Place the other cylinder in the freezer and leave overnight.

#### Day 2

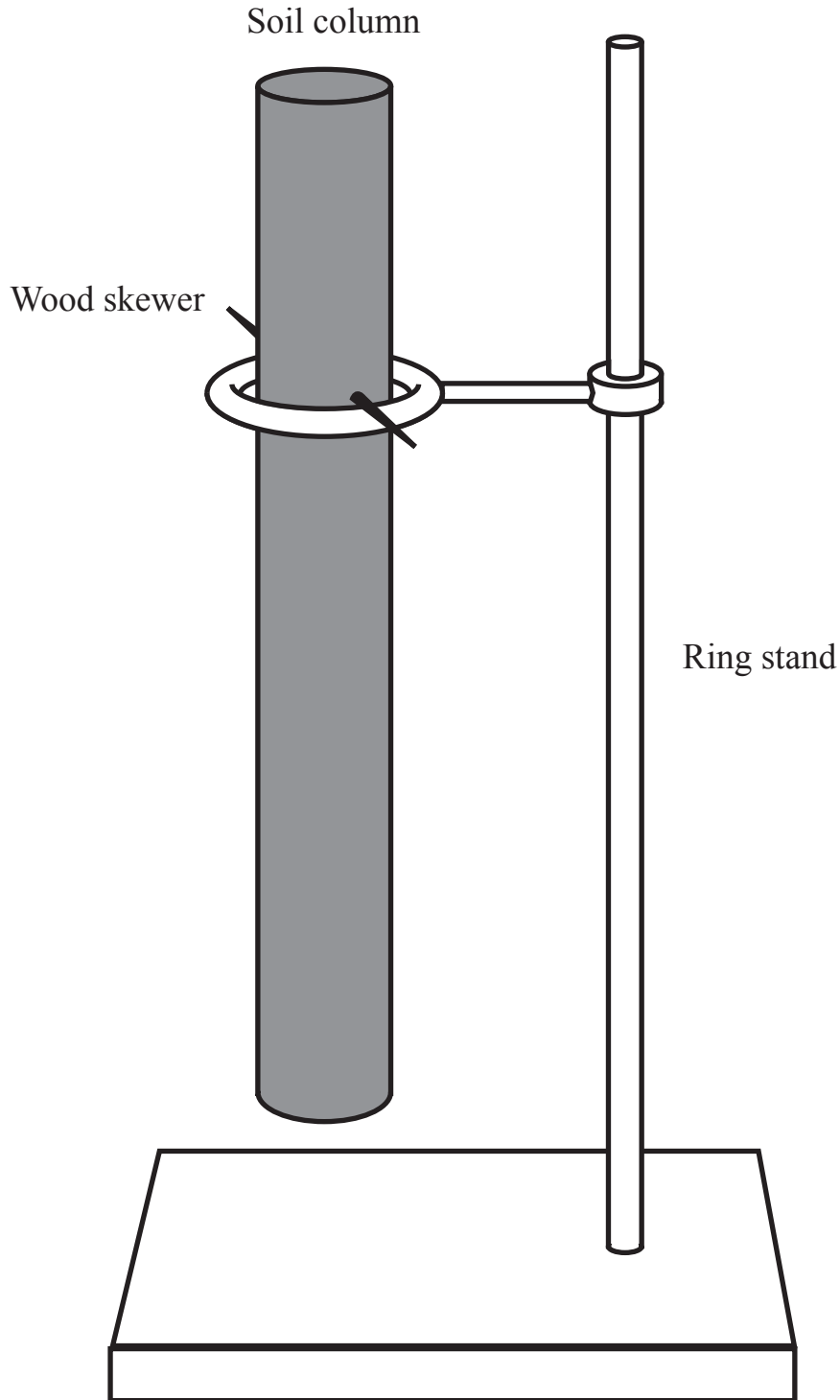
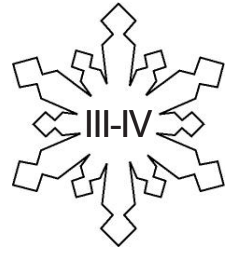
- STEP 5.** The next day, suspend both cylinders upright in a ring stand by poking one skewer through each column, perpendicular, about a quarter way down the column from the top (see diagram on next page).
- STEP 6.** Add several drops of food coloring to a beaker filled with cold water. Mix well.
- STEP 7.** Use a graduated cylinder to measure 150 milliliters of dyed water. Place an empty beaker under the cylinder to catch the percolation and pour the water into the first column.
- STEP 8.** Observe the movement of water through the soil sample.
- STEP 9.** Pour the percolated water into the graduated cylinder to measure. Record the amount of water on the data table below, and discard the water. Also record your observations of the percolation.
- STEP 10.** Repeat steps 7 – 9 for the remaining soil column.

Name: \_\_\_\_\_

# Soil Permeability Experiment

## Student Worksheet (page 3 of 5)

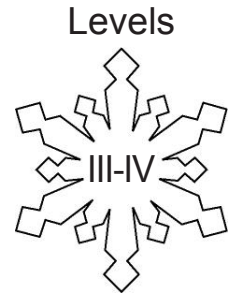
Levels



Name: \_\_\_\_\_

# Soil Permeability Experiment

## Student Worksheet (page 4 of 5)



**Data:**

2. Record your data in the table below.

	Frozen Soil	Non-frozen soil
Amount of percolated water (millimeters)		
Observations		

**Data Analysis:**

3. Which soil column is more permeable? \_\_\_\_\_

**Conclusion:**

4. Do the results of your experiment support your hypothesis? Explain why or why not.

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**Questions:**

5. How could you modify this experiment to improve the reliability of your results?

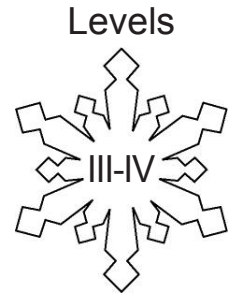
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Name: \_\_\_\_\_

# Soil Permeability Experiment

## Student Worksheet (page 5 of 5)



6. Compare the model used in this experiment to permafrost in the environment. What is the same? What is different?

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7. Plants need water to survive. However, too much water will drown a plant.
- A. How might plants be affected if the permafrost thaws and the active layer becomes saturated?

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- B. How might plants be affected if the permafrost thaws completely?

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