# PERCOLATION AND THE PERMAFROST



Prep Time: 30 minutes
Teaching Time: 3 hours
Note: This lesson will take two class periods. One for preparation and a second to perform the activity.

## Science Concept:

Percolation is part of the water cycle and can be affected by environmental conditions.

## Objectives:

The student will:

- identify how permafrost and weather phenomena are connected;
- make and record observations and predictions; and
- graph data.

## GLEs Addressed:

*Science*

[6] SD3.1 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by connecting the water cycle to weather phenomena.

[6] 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.

*Math*

[6] S&P-1 The student demonstrates an ability to classify and organize data by designing an investigation and collecting, organizing, or displaying using appropriate scale for data displays (tables, bar graphs, line graphs, or circle graphs), data in real-world problems (e.g., social studies, friends, or school), with whole numbers up to 100.

## Vocabulary:

*continuous* - forming an unbroken whole; without interruption
*discontinuous* - having intervals or gaps
*percolation* - (of a liquid or gas) filter gradually through a porous surface or substance
*permafrost* - a thick subsurface layer of soil that remains below freezing point throughout the year, occurring chiefly in polar regions
*soil column* - vertical distribution of soil types

## Materials:

- Fine soil, packaged and sterile (at least one 3# size coffee can full per group)
- Heavy stock plastic transparency sheets (three per group)
- Clear packing tape
- Food coloring
- Beaker, 200-millilter or larger (two per group)
- Water
- Scissors (one per group)
- Pans (one per group and one for Gear Up)
- Wood skewers (three per group)
- Sponges (four to six per group)
- 200-milliliter graduated cylinder (one per group)
- Nylon sock, for screen (three per group)
- Ring stands (three per group)
- STUDENT INFORMATION SHEET: "Soil Column Experiment"

## Activity Preparation:

Saturate half of the sponges with water and freeze until solid. The remaining sponges will remain unfrozen, but should also be saturated with water prior to the lesson.

**Teacher's Note:** This lesson will take two class periods. One day for the preparation of the experiment and the second day to perform it.

## Activity Procedure:

Please refer to the assessment task and scoring rubric located at the end of these instructions. Discuss the assessment descriptors with the class before teaching this lesson.

**Gear Up**

***Process Skills: observing, predicting, and inferring***

1. Do the following demonstration where all students can see; however, they should not be able to see that the sponges are frozen or unfrozen.
2. In a pan, place one frozen sponge and one saturated but unfrozen sponge on the sheet. Slowly pour water over each sponge and instruct students to observe and record their observations. Discuss the differences in how the water acted on each sponge. Allow students to investigate enough to determine that one of the sponges is frozen. Instruct students to record new observations. As a class, discuss students' new observations.
3. Instruct students to write five things they know about permafrost and share two of them with the class.
4. Lead a discussion to help students make the connection between the sponges and permafrost by including such things as where permafrost is found and types of permafrost (continuous and discontinuous).

**Teacher's Note:** In the continuous zone of the far north, permafrost is present nearly everywhere except under the lakes and rivers that do not freeze to the bottom. The discontinuous zone includes numerous permafrost-free areas that increase progressively with size.

**Explore**

***Process Skills: observing and predicting***

5. Divide students into small groups. Ask groups to write a prediction in their science journal about what will happen when they put the sponges together in different patterns and pour water through them. Distribute sponges (both frozen and unfrozen), pans, and water to each group. Let groups explore with the materials given. Students should write at least four observations about their exploration. Encourage students to make drawings of what they observe. Instruct students to write how their sponges resembled, and did not resemble, continuous and discontinuous permafrost.

**Generalize**

***Process Skills: communicating and predicting***

6. Ask students the following questions and discuss as a class:
   a. What do the sponges represent?
   b. How are the sponges similar to permafrost?
   c. How are the sponges different than permafrost?
   d. Why did the water move as it did through the different patterns of sponges?
   e. How are the layers of a sponge similar to the layers of permafrost?
   f. How does permafrost form?
   g. How could permafrost be important to the land?

**Experiment**

***Process Skills: observing, measuring, controlling variables, making graphs, experimenting, and collecting data***

7. Explain that students will be making three different soil columns. Demonstrate how to make a soil column by completing the following steps.
   STEP 1. Roll three sheets of clear plastic transparencies into three 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 the soil column. Before attaching, poke several large holes into the nylon so it will not effect the percolation of the soil column. Attach the nylon with tape to the bottom of the soil column.
   STEP 3. Fill two cylinders completely full with soil and the third cylinder halfway full of soil. Pack the soil as firmly as possible without damaging the plastic containers. One of the full cylinders will be the control in the experiment.
8. Ask students to form a hypothesis regarding what will happen when water is applied to each of the three different soil columns. This hypothesis must be testable. (NOTE: The experiment will take two class periods. One day for the preparation of the experiment and the second day to perform it.)
9. Distribute a set of materials to each group: transparency sheets, tape, soil, nylon sock, scissors, and a 200-milliliter graduated cylinder. Distribute the STUDENT INFORMATION SHEET: "Soil Column Experiment" and instruct students to complete the first five steps.
10. The following day, distribute wooden skewers, ring stands, beakers, and food coloring to each group. Instruct groups to complete the remainder of the experiment.

**Interpret**

***Process Skills: analyzing, interpreting, inferring, and communicating***

11. As a class, discuss results and make sure each student can explain what happened and why. A spokesperson from each group should share their results and inferences with the class.
12. Ask students to analyze their data table by comparing the percolation times. Instruct students to create a labeled bar graph of the percolation times for each soil column. They also could include graphs of data from other groups.

**Apply**

***Process Skill: communicating***

13. Instruct students to write about the possible effects of permafrost thaw on the arctic environment, based on the results of their experiment.

# PERCOLATION AND THE PERMAFROST

RUBRIC

## Assessment Task

In their science notebook, ask students to describe at least one way that large-scale weather phenomena, like global warming, could affect permafrost in the Arctic and, in turn, how percolation through the soil would be affected. Instruct students to include a discussion of the water cycle in the description.

## Rubric

| Objective | GLE | Below Proficient | Proficient | Above Proficient |
|---|---|---|---|---|
| The student identifies how permafrost and weather phenomena are connected. | [6] SD3.1 | The student does not connect permafrost (with the water cycle) and weather phenomena. | The student identifies one way how permafrost, the water cycle, and weather phenomena such as global warming are connected. | The student identifies two or more ways permafrost, the water cycle, and weather phenomena such as global warming are connected. |
| The student makes and records observations and predictions. | [6] SA1.1 | The student does not make or record predictions and observations regarding percolation through the different soil columns. | The student makes and records predictions and observations regarding percolation through the different soil columns. | The student makes and records predictions and observations regarding percolation through the different soil columns. Analysis contains inferences and suggestions for further investigations. |
| The student graphs data. | [6] S&P-1 | The student makes an attempt at graphing data, but title, labels, or scale is missing. | The student graphs data. The graph contains a title, axis labels, and scale. | The student graphs data. The graph contains a title, axis labels, and appropriate scale. In addition, the student includes at least one graph of data from another group. |

## Materials

- 3 transparency sheets
- Clear plastic tape
- 3 nylon socks
- Soil
- 3 ring stands
- 3 wooden skewers
- 2 beakers, 200-milliliters or larger
- food coloring
- graduated cylinder, 200 milliliters or larger

## Procedure

STEP 1: Roll three sheets of clear plastic transparencies into three 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 the soil column. Before attaching, poke several large holes into the nylon so it will not effect the percolation of the soil column. Attach the nylon with tape to the bottom of the soil column.

STEP 3: Fill two cylinders completely full with the soil and the third cylinder halfway full of the soil. Pack the soil as firmly as possible without damaging the plastic containers. One of the full cylinders will be the control in the experiment.

STEP 4: Place one of the full cylinders and the cylinder that is half full in the freezer.

STEP 5: Create a data table (see example below) for recording amount of percolation of all three columns.

| | Full Frozen | Half-full Frozen | Full Non-frozen |
|---|---|---|---|
| Amount of Water (milliliters) | | | |

STEP 6: The next day, fill the cylinder that was half full with moistened soil so that all three cylinders are now full. Suspend all three cylinders upright in a ring stand by poking one skewer through each column perpendicularly about a quarter way down the column from the top (see diagram below).

STEP 7: Add several drops of food coloring to a beaker filled with cold water. Mix well.

STEP 8: 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 9: Observe and record in your science notebook the movement of water through the soil sample.

STEP 10: Pour the percolated water into the graduated cylinder to measure. Record the amount of water on your data table and discard the water. Also record your observations of the percolation.

STEP 11: Repeat steps 8 – 10 for the remaining two soil columns.