

# Permafrost

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## Overview:

Students analyze soil temperature data to determine which soil sample is permafrost and explore the affect the active layer plays on permafrost structure.

## Objectives:

The student will:

- use a thermometer to accurately measure temperature;
- define permafrost;
- identify the active layer; and
- identify permafrost.

## BSSD Standards Addressed:

### *Science*

- SC 03.09 Records, collects and explains data.
- SC 03.10 Applies and accurately reads appropriate scientific instruments.
- SC 03.18.a Understanding of the interactions between matter and energy and the effects of these interactions on systems by identifying physical and chemical changes based on observable characteristics (e.g. tearing paper vs. burning paper).
- SC 03.18.b Understanding of the interactions between matter and energy and the effects of these interactions on systems by recognizing that most substances can exist as a solid, liquid, or gas depending on temperature.

## 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.
- [6] SB1.1 The student demonstrates an understanding of the structure and properties of matter by using models to represent matter as it changes from one state to another.
- [6] SB3.1 The student demonstrates an understanding of the interactions between matter and energy and the effects of these interactions on systems by recognizing that most substances can exist as a solid, liquid, or gas depending on temperature.
- [7] SG3.1 The student demonstrates an understanding that scientific knowledge is ongoing and subject to change by revising a personal idea when presented with experimental/observational data inconsistent with that personal idea (e.g., the rates of falling bodies of different masses).

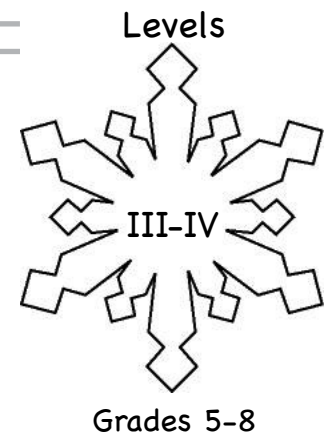
### *Math*

- [5] MEA-4 The student demonstrates ability to use measurement techniques by measuring temperature or weight using appropriate tools.

## Vocabulary:

**permafrost** – ground (rock or soil) that remains frozen all year

**active layer** – the top portion of soil that thaws during the summer



## Materials:

- Soil
- Straw
- Styrofoam cups (2 per pair of students)
- Thermometers, narrow enough to fit inside straw (1 per pair of students)
- OVERHEAD: “Active Layer”
- STUDENT WORKSHEET: “Permafrost”

## Activity Preparation:

Place a straw in each Styrofoam cup and fill halfway with soil to surround the straw. There should be two cups per pair of students. Place half the cups in the freezer at least one day before proceeding with the “Activity Procedure.”

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**Teacher’s Note:** Students are asked to use their frozen soil two times during the lesson. Frozen soil can be placed in the freezer between the two activities to ensure it stays frozen, or two sets of frozen soil can be made per pair: one for the first activity in Activity Procedure 3; and one for the second activity in Activity Procedure 9.

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## Activity Procedure:

1. Ask students what they know about permafrost. Ask guiding questions, as necessary, to make sure that student’s ideas are clear and represented correctly. List all ideas on the board. Explain that by collecting ideas now, the class can look at them critically later and see how they have changed over time.
2. Explain permafrost is permanently frozen ground (soil or rock) that remains frozen, below 32°F (0°C), all year.
3. Divide students into pairs. Distribute a thermometer, one cup of room temperature soil, and one cup of frozen soil to each pair. Ask students to measure the temperature of each cup of soil by placing the thermometer into the straw.
4. Ask students to label their cups, labeling one “permafrost” and the other “soil.” The cup that is at a temperature near or below 32°F (0°C) should be labeled permafrost. Verify students have correctly labeled their cups.
5. Ask students what will happen if the “permafrost” is left outside of the freezer. (*It will rise in temperature and become regular soil again.*)

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**Teacher’s Note:** If only one set of frozen soil per pair was created, ask students to place their soil back into the freezer to assure it stays frozen for Activity Procedure 9.

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**Critical Thinking Question: Puzzle Method.** Develop students’ critical thinking by providing clues to the following puzzle: Most tundra plants cannot grow in frozen soil, but permafrost is found in many areas that contain vegetation. Divide students into groups and provide them adequate time to suggest an explanation for the puzzle. Ask students to share their ideas and their reasoning.

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6. Show OVERHEAD: “Active Layer.” Explain there is a layer of soil above permafrost called the active layer; if it warms up enough, permafrost will melt, but the active layer keeps the permafrost cool enough to stay frozen all year, even through the Arctic summer.
7. If students are not already familiar with the terms, introduce the terms “insulation” and “insulator.” Explain the active layer of soil is an insulator for the permafrost. It slows down the process of heat transfer from the atmosphere to the frozen ground. Ask students to name other insulators for permafrost. (*snow, ice, plants, etc.*)

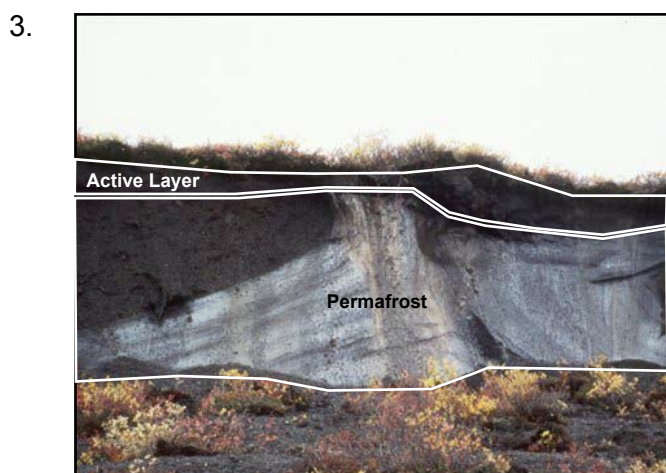
8. If students mention buildings as an insulator, point out that some materials are conductors, carrying heat from one object to another. Buildings are often conductors of heat, carrying the heat from the building into the soil; that is why many buildings in permafrost zones are built on pilings.
9. Ask pairs to combine into groups of four so that each group has two cups of frozen soil and two cups of room temperature soil. Instruct students to fill one of their “permafrost” cups with dry soil and leave the other cup as it is. Ask groups to create a data chart, such as shown below, and measure the temperature of each cup every 30 seconds for 5 minutes. Remind students to number and title data tables, and to write units in the column headings.

Time	Temperature of permafrost without active layer (°F)	Temperature of permafrost with active layer (°F)
30 sec		
1 min		
1.5 min		
2 min		

10. Ask groups to create a graph of their data and share their results. Make sure students label their graphs and include units, a title, and a key.
11. Return to the list of student ideas collected in Activity Procedure 1. Ask students if any of their ideas have changed or been refined or if they would like to add anything to the list. This list can be revisited as the class progresses through the other lessons in this unit.
12. Remind students that permafrost is ground (soil or rock) that stays frozen all year and the active layer insulates the permafrost from the outside air.
13. Distribute the STUDENT WORKSHEET: “Permafrost” and instruct students to complete the worksheet individually.

## Answers:

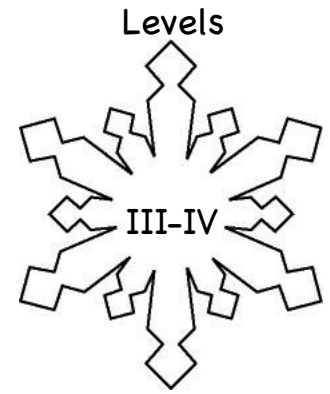
1. C. Ground that is frozen all year
2. B. Sample B. Student reasoning should indicate that permafrost will be below 32°F (0°C) all year. Partial credit should be given for answers that indicate permafrost is below 32°F (0°C), but do not specify or support that it is frozen all year.



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

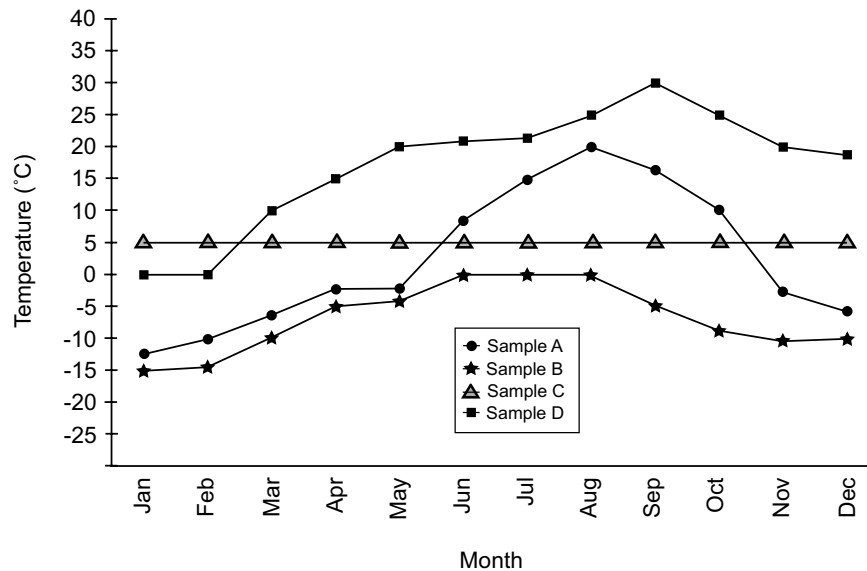
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## Student Worksheet



**Directions:** Answer the following questions.

1. What is permafrost?
  - A. Ice
  - B. Rock or soil that is frozen during the winter
  - C. Ground that is frozen all year
  - D. Surface soil that never thaws
2. The following graph shows temperature measurements of three soil samples. Which soil sample is permafrost? Explain your reasoning.
  - A. Sample A
  - B. Sample B
  - C. Sample C
  - D. Sample D



Explain your reasoning: \_\_\_\_\_

3. Label the active layer in the image below.

