

# Permafrost Inquiry

## Overview

Permafrost puts extensive limitations on plant growth and building construction. Most students in the world are not exposed to this phenomenon and don't have a clear concept of what it is or how it is at risk. This inquiry activity is designed to let them explore the impact of melting permafrost on a human structure.

## Objectives

1. At the conclusion of this activity, students will be able to state what permafrost is and where it is found.
2. Students will design an experiment to demonstrate the effect of permafrost melt on structures.

## Lesson

### Preparation

Begin by discussing what permafrost is and where it can be found in the world; it is soil that has been frozen solid for more than two years. Using the schematic and map on the Weather Underground's 'Permafrost' page (<https://www.wunderground.com/climate/permafrost.asp> (<https://www.wunderground.com/climate/permafrost.asp>)), explain the layers of Arctic soil. The active layer above the permafrost thaws during the summer, so all biological activity occurs there. While there is some permafrost in alpine regions around the world, most permafrost can be found in Arctic regions, especially Siberia, Greenland, and Alaska. 10% of land in the northern hemisphere is underlain by permafrost. Permafrost soil forms the foundation of the tundra biome, a system that supports small plants, often dwarf versions of species found in warmer locales. Humans have lived on the tundra for millennia in small, often nomadic, communities. However, modern construction is less suited for tundra conditions because large, warm foundations cause permafrost to melt, causing buildings to sag and collapse.

Additionally, global climate change is inducing permafrost melt at an accelerating rate. The risk to Arctic communities' buildings and infrastructure is quite high. The activity described below is designed to let students explore risks associated with permafrost melt. It could be conducted with more or less scaffolding, depending on the experience of the students with inquiry activities.

## Procedure

### DAY 1

1. Provide students with a basic set up:
  - a. Put wet material (sand OR soil) into a jar, filling about 1/3 full. Put several ice cubes on top. Fill with more of the same wet material. Note that the ice cubes represent ice wedges that form when melt water seeps into through permafrost and then refreezes.
  - b. Measure and record the size of each layer (centimeters).

### Details

- 📌 Lesson
- 🌐 Arctic
- 🕒 Less than a week
- 📄 Download, Share, and Remix
- ✍ Middle School and Up

### Materials

Clear, wide-mouthed plastic containers or jar (approximately 500 mL) per group  
3-6 ice cubes per group  
Sand and local soil (enough to fill one jar per group)  
One scoop or small shovel to move soil and sand per student group  
Modelling clay and/or other construction materials  
Twigs (optional)  
Water  
Freezer  
Student Investigation Sheet  
Rubric

- c. This material could be soil or sand.
  - d. An alternative would be to allow students to select their own materials.
  - e. Write a list of the materials used if they were not specified by the teacher.
2. Put the permafrost models into the freezer overnight.

## DAY 2

3. Write a hypothesis as a statement about what is expected to buildings placed on permafrost when it later melts and why this change is anticipated.
4. Construct buildings.
  - a. Use modeling clay to construct any sort of structure.
  - b. An alternative would be to allow students to use materials of their choice to create buildings, forests, or constructs of their choice. For example, students might want to use twigs, LEGOs, or other objects.
  - c. Describe the structure.
5. Allow permafrost models to thaw overnight.

## DAY 3

4. Observe. What changes have taken place in each model? Briefly, allow students to go on a museum tour and observe other groups' models.
5. Collect class data. Using a projected spreadsheet or a black/whiteboard, have a student representative from each group record test conditions and results.

## Discussion Questions

1. What happened to the surface of the ground when the permafrost thawed? How did this affect your structure?
2. Look at other groups' models. Did using different materials cause different outcomes? In what way(s)?
3. Permafrost contains large quantities of stored organic carbon; this is in the plants and roots that have not decayed because the ground is so cold. How might the tundra ecosystem change as permafrost melts? Explain what might happen to the plant and animal communities.

## Resources

1. "Permafrost". Weather Underground. The Weather Company. 2016. <https://www.wunderground.com/> ([https://www.wunderground.com/ climate/permafrost.asp](https://www.wunderground.com/climate/permafrost.asp); Carlson, D., Munroe, N., Salmon, R. "Permafrost Demonstration".
2. IPY International Programme Office. PolarTREC. [https://www.polartrec.com/files/resources/activity/34708/docs/land\\_1.pdf](https://www.polartrec.com/files/resources/activity/34708/docs/land_1.pdf) ([https://www.polartrec.com/files/resources/activity/34708/docs/land\\_1.pdf](https://www.polartrec.com/files/resources/activity/34708/docs/land_1.pdf))

## Assessment

Download the attached rubric. Students will be evaluated on the basis of model design and description, clear hypothesis, and a thorough explanation of the outcome and the implications of permafrost melt for tundra communities.

## Author/Credits

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## PERMAFROST INQUIRY – RUBRIC

	4	3	2	1
<b>Model Design &amp; Description</b>	Measurements and descriptions are accurate and complete.	Measurements are inaccurate, but descriptions are complete.	Measurements are accurate, but descriptions are incomplete.	Measurements are inaccurate, and descriptions are incomplete.
<b>Hypothesis</b>	Hypothesis specifies conditions and makes a clear claim with a thoughtful rationale.	Hypothesis makes a clear claim with a thoughtful rationale.	Hypothesis specifies conditions with a clear claim.	Hypothesis lacks conditions and rationale.
<b>Explanation</b>	Explanation of outcome is clear and thorough.	Explanation of outcome appears to be thorough.	Explanation of outcome is incomplete.	Response is minimal.
<b>Implications</b>	Ideas about the future of the tundra make sense and are supported by facts.	An idea about the future of the tundra makes sense and is supported by a fact.	Idea(s) about the tundra are not supported by facts.	Idea(s) about the tundra do not make sense.

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

Date: \_\_\_\_\_

Lab Role: \_\_\_\_\_

## **PERMAFROST INQUIRY – STUDENT INVESTIGATION SHEET**

### Objectives

1. At the conclusion of this activity, students will be able to state what permafrost is and where it is found.
2. Students will design an experiment to demonstrate the effect of permafrost melt on structures.

### Materials

Clear, wide-mouthed plastic containers or jar (approximately 500 mL) per group  
Ice cubes  
Sand and local soil (enough to fill one jar with each)  
One scoop or small shovel to move soil and sand per student group  
Toothpicks  
Modelling clay and/or other construction materials  
Twigs (optional)  
Water  
Freezer  
Student Investigation Sheet Rubric

### Procedure

#### **DAY 1**

1. Fill permafrost jar about 1/3 full with wet soil, sand, or other material. Do NOT mix them!
2. Put several ice cubes on top. Fill with more of the same wet material. Note that the ice cubes represent ice wedges that form when melt water seeps into through permafrost and then refreezes.
3. Measure and record the size of each layer (centimeters). Describe each layer.

4. Put the permafrost models into the freezer overnight.

#### **DAY 2**

5. Write a hypothesis as a statement about what is expected to happen to buildings placed on permafrost when it later melts and why this change is anticipated.
6. Construct buildings. Use toothpicks to anchor the buildings.
7. Describe the structure.

8. Allow permafrost models to thaw overnight.

#### **DAY 3**

9. Observe your model and those of the other groups.
10. Collect class data on a projected spreadsheet or a black/whiteboard. Record the materials used and the result.

## DISCUSSION QUESTIONS

1. What happened to the surface of the ground when the permafrost thawed? How did this affect your structure?
2. Look at other groups' models. Did using different materials cause different outcomes? In what way(s)?
3. Permafrost contains large quantities of stored organic carbon; this is in the plants and roots that have not decayed because the ground is so cold. How might the tundra ecosystem change as permafrost melts? Explain what might happen to the plant and animal communities that live there now. Your answer should be a complete paragraph.