

SESSION 4: SNOLAB & THE SCIENTIFIC METHOD

~45 minutes

SESSION OVERVIEW

In this session, students will revisit the various unique conditions seen at SNOLAB, which include higher pressure, no natural light, and fewer cosmic rays. These conditions make certain types of research possible by reducing interference and creating a controlled environment. Understanding these factors will help students begin thinking about experiments that could take advantage of SNOLAB's unique setting.

LEARNING GOALS

- **Describe** the unique conditions at SNOLAB
- **Explain** how certain conditions can affect a scientific experiment
- **Investigate** why scientists conduct certain experiments deep underground
- **Apply** their knowledge of SNOLAB's unique conditions to different contexts
- **Communicate** their thinking using proper scientific vocabulary



Investigate



Communicate

SCIENTIFIC BACKGROUND

Scientific experiments are influenced by the environment in which they are performed. SNOLAB's location 2 km underground provides unique conditions, such as reduced cosmic rays, higher pressure, and controlled temperatures, which allow scientists to carry out highly sensitive experiments. Exploring how these conditions affect research helps students understand why the setting of an experiment is an important part of its design.

CURRICULUM CONNECTIONS

Science & Technology

- Grade 4-8: A1.1 - A1.5

Language Arts

- Grade 4-8: A1.2, A3.1, B1.1, B1.2

*The Arts

- Grade 4-8: B1.1 & B1.2

*Science & Technology

- Grade 8: C2.6

* Indicates an extension activity connection

SESSION 4: SNOLAB & THE SCIENTIFIC METHOD

~45 minutes

MATERIALS

- Session 4 presentation
- Laptop
- SMART board or projector
- Kettle
- Timer
- Thermometer

DISCUSSION PROMPTS

Before

- How might doing an experiment in a different location change the results?
- What differences do you predict between an experiment performed at the surface versus underground?
- Which condition at SNOLAB do you think would have an impact on an experiment?

During

- What variables are we controlling in this experiment? Why is that important?
- Why is it important to understand the conditions where an experiment is performed?
- Is there any other data we could collect for this kettle experiment?

After

- What did this experiment show us about how environmental conditions can affect scientific results?
- What factors do you need to consider if you were designing an experiment for SNOLAB?
- How could you use what you learned today to design a better scientific investigation?

EXTENSIONS & ASSESSMENT

STEM focused: Marshmallow pressure experiment

- Students explore how changing pressure affects objects using a tasty treat

Cross-curricular: SNOLAB charades (Drama)

- Students express their understanding by acting out conditions at SNOLAB

Assessment: Session 4 Exit ticket

See the appendix for more details on this section

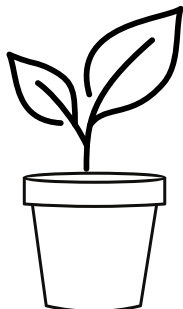


SESSION 4

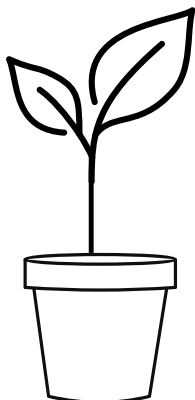
- SNOLAB & the scientific method Exit Ticket (Grade 4 - 6)
- SNOLAB & the scientific method Exit Ticket (Grade 7 - 8)
- SNOLAB & the scientific method Worksheet Answer Keys
- Extension Activity: SNOLAB charades (optional)
- Extension Activity: Under pressure (optional)



Name: _____



Underground



On surface

The Experiment

Scientists at SNOLAB are growing the same plants underground and on surface. They use the same type of soil and give them the same amount of water. After some time, the scientists notice the plants are growing differently in the two places.

1

What was the **SMART** scientific question the scientists used for the experiment? Circle the answer.

Do plants grow differently underground than on surface?

Does temperature affect how fast an ice cube melts?

2

Use the word bank below to fill in the blanks to find the variables for the experiment.

Plant height

Amount of soil

Location (Place)

Amount of water

a) The independent variable (what is changing) is _____

b) The dependent variable (what is being measured) is _____

c) The control variables (what is staying the same) are _____

and _____

3

Why was the plant grown underground shorter than the one grown on surface? Circle the correct option.

There is **MORE / LESS** pressure underground.



SNOLAB & THE SCIENTIFIC METHOD

Name: _____

Plant ID	Height (cm)
Underground 1	5.8 cm
Underground 2	6.1 cm
Underground 3	5.4 cm
Surface 1	6.5 cm
Surface 2	6.3 cm
Surface 3	7.1 cm

The Experiment

Scientists at SNOLAB are investigating if plants grow differently underground than on surface. They plant three plants in each location with the same amount of soil and water. Each week, they measure the plants' height with a measuring tape. After four weeks, they obtain the results shown in the table.

1

Calculate the mean, median, mode, and range for the results of the experiment

2

Identify the following information for the experiment.

SMART question:

Independent variable:

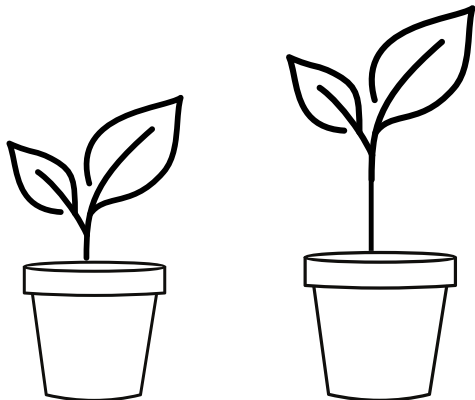
Dependent variable:

Control variable(s):

3

What is a possible explanation for the results observed in this experiment? Think about SNOLAB's unique conditions as an underground science lab.

Name: TOTAL: 6 points



Underground

On surface

The Experiment

Scientists at SNOLAB are growing the same plants underground and on surface. They use the same type of soil and give them the same amount of water. After some time, the scientists notice the plants are growing differently in the two places.

1

What was the SMART scientific question the scientists used for the experiment? Circle the answer.

Do plants grow differently underground than on surface?

Does temperature affect how fast an ice cube melts?

1 point

2

Use the word bank below to fill in the blanks to find the variables for the experiment.

Plant height Amount of soil Location (Place) Amount of water

a) The independent variable (what is changing) is Location (place)

b) The dependent variable (what is being measured) is Plant height

c) The control variables (what is staying the same) are Amount of water

and Amount of soil

4 points

3

Why was the plant grown underground shorter than the one grown on surface? Circle the correct option.

1 point

There is MORE / LESS pressure underground.



SNOLAB & THE SCIENTIFIC METHOD

Name: TOTAL: 14 points

Plant ID	Height (cm)
Underground 1	5.8 cm
Underground 2	6.1 cm
Underground 3	5.4 cm
Surface 1	6.5 cm
Surface 2	6.3 cm
Surface 3	7.1 cm

The Experiment

Scientists at SNOLAB are investigating if plants grow differently underground than on surface. They plant three plants in each location with the same amount of soil and water. Each week, they measure the plants' height with a measuring tape. After four weeks, they obtain the results shown in the table.

1 Calculate the mean, median, mode, and range for the results of the experiment

Underground

$$\text{Mean} = 5.8 + 6.1 + 5.4 = 17.3 / 3 = 5.76$$

$$\text{Median} = 5.8$$

$$\text{Mode} = N/A$$

$$\text{Range} = 6.1 - 5.4 = 0.7$$

Surface

$$\text{Mean} = 6.5 + 6.3 + 7.1 = 19.9 / 3 = 6.63$$

$$\text{Median} = 6.5$$

$$\text{Mode} = N/A$$

$$\text{Range} = 7.1 - 6.3 = 0.8$$

8 points

2 Identify the following information for the experiment. 4 points

SMART question:

Do plants grow better underground or on surface?

Independent variable:

Plant location

Dependent variable:

Plant height

Control variable(s):

Amount of water and soil

3 What is a possible explanation for the results observed in this experiment? Think about SNOLAB's unique conditions as an underground science lab. 2 points

One possible explanation for this observation is that the underground lab at SNOLAB has more pressure than the surface, which could cause the plants' growth to be limited.



SNOLAB CHARADES

MATERIALS

- Printed SNOLAB charade cards
- Timer

INSTRUCTIONS

Team activity

1. Divide students into teams of 2-4
2. One student draws a clue card without showing anyone
3. The student must silently act out the clue. No speaking, sounds, or spelling words
4. Their team has one minute to guess, and award 1 point if they guess correctly.
5. After each guess, briefly discuss why the condition exists at SNOLAB

Whole class activity

1. Select one student to begin the activity
2. The student draws a clue card without showing anyone
3. The student must silently act out the clue. No speaking, sounds, or spelling words
4. The class has one minute to guess
5. The first student to correctly guess the clue is next to act one out
6. After each guess, briefly discuss why the condition exists at SNOLAB

Class in teams activity

1. Divide the class into two teams (as equal as possible)
2. Select one team to go first. They must choose a person from their team to draw a clue card without showing anyone
3. The student must silently act out the clue. No speaking, sounds, or spelling words
4. Their team has one minute to guess; if they do not guess in time, the other team has an opportunity to steal the point
5. The team who correctly guesses the clue is awarded 1 point
6. After each guess, briefly discuss why the condition exists at SNOLAB
7. Repeat the same steps with a student from the other team acting out the clue

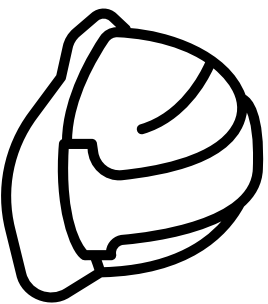
DISCUSSION QUESTIONS

- Which underground condition was easiest to act out/guess? Which was the hardest?
- What surprised you most about the conditions at SNOLAB?
- How is SNOLAB different from a regular laboratory or classroom?
- What advantages does an underground lab provide? What challenges might it provide?

CURRICULUM CONNECTIONS

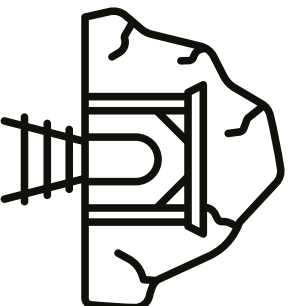
- Science & Technology: A3.1, A3.2
- The Arts: B1.1, B1.2

Putting on a hard hat



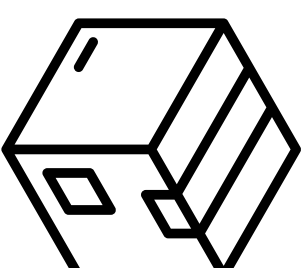
Fact: Everyone must wear lots of personal protective equipment (PPE) underground

Riding the cage underground



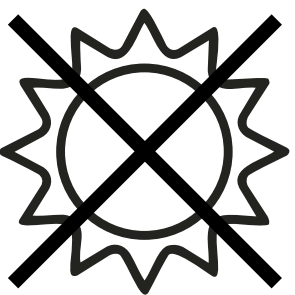
Fact: Scientists travel about 2 km underground to reach SNOLAB

Carrying an object carefully



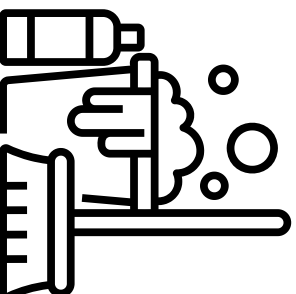
Fact: Sensitive equipment must be transported carefully underground

No sunlight underground



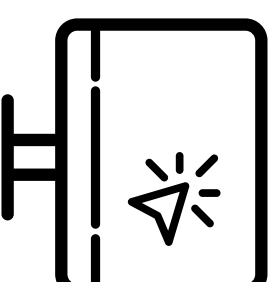
Fact: No natural sunlight reaches the lab underground, it is lit with artificial lights

Very clean lab space



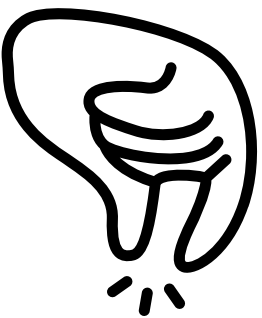
Fact: SNOLAB is a class 2000 clean lab, which prevents dust from dirtying experiments

Working on a computer



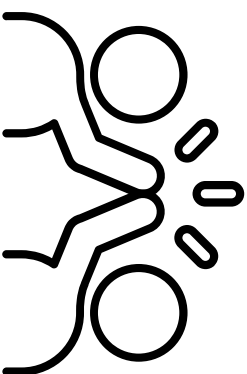
Fact: Scientists use computers to monitor experiments and record data underground.

Looking for
something tiny



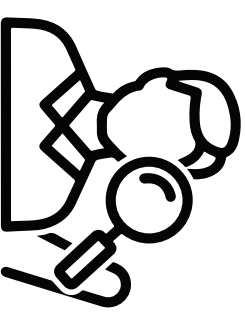
Fact: SNOLAB experiments look for very tiny particles that are hard to detect.

Scientists working
together



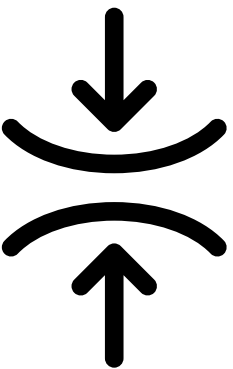
Fact: Scientists work together on experiments at SNOLAB to help make them better

Watching
experiments
carefully



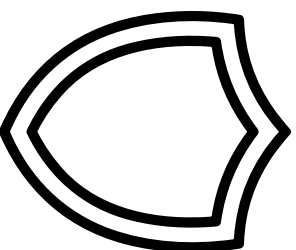
Fact: SNOLAB scientists carefully watch data to observe anything new or unusual

Higher pressure
underground



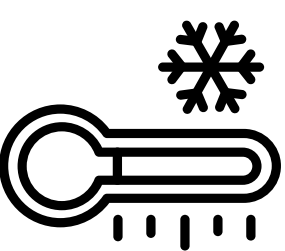
Fact: The 2 km of rock above the lab creates very high pressure compared to surface

Shield from space
particles



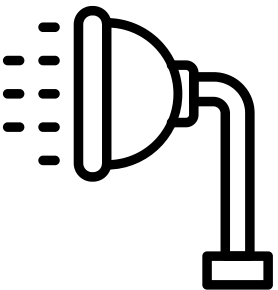
Fact: The rock above the lab acts like a shield that blocks many particles from space

Liquid nitrogen
cooling



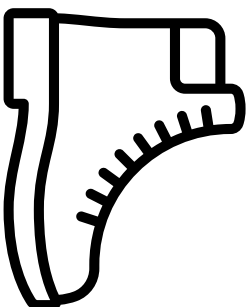
Fact: Some experiments use very cold temperatures and cryogenics to help get data.

Taking a shower underground



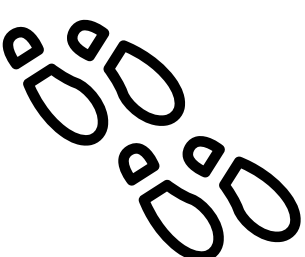
Fact: Scientists must take a shower underground before entering the clean lab area.

Using the boot wash station



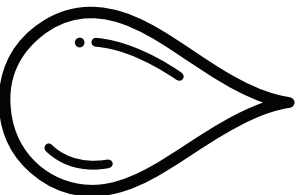
Fact: All boots must be washed before entering the clean lab area from the mine

Walking in the drift underground



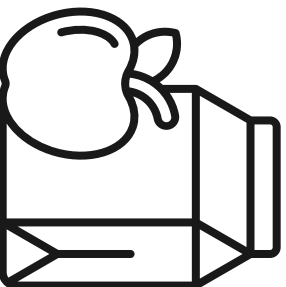
Fact: To get to the lab, scientists need to walk 1.4 km in a mine tunnel called a drift

Using ultra-pure water



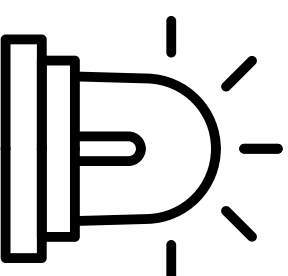
Fact: SNOLAB makes ultra-pure water that has no impurities and uses it for experiments

Eating lunch underground



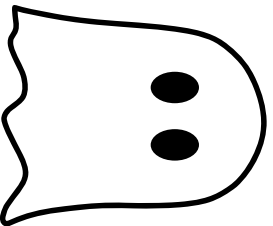
Fact: Workers and scientists take breaks and eat meals in designated areas underground

Emergency refuge station



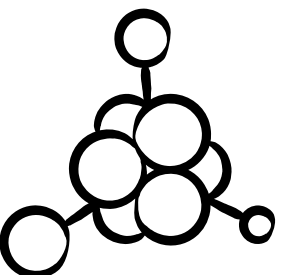
Fact: Refuge stations are safe underground areas that protect workers during emergencies

Finding ghost particles



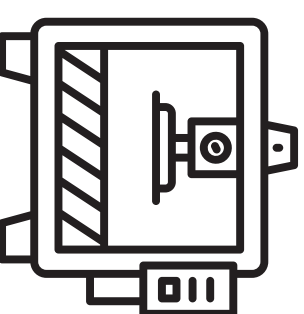
Fact: Scientists study “ghost particles” called neutrinos that pass through almost anything

Detecting a particle signal



Fact: Tiny signals from particles are very rare, but can be seen underground at SNOLAB

Particle detection machines



Fact: Scientists use detectors to observe tiny particles and record their movements



UNDER PRESSURE

MATERIALS

- Needleless syringes (10-50 mL)
- Marshmallows
- Under pressure worksheet
- Optional: Edible markers (helps track visual changes)

INSTRUCTIONS

1. Briefly review the unique conditions at SNOLAB, paying particular attention to pressure
2. Divide students into groups of 2-3 (or stay as a whole-group, if preferred)
3. Pass out all materials required for the activity
4. Students discuss the SMART question being asked in this investigation. They should also come up with predictions and variables for the experiment
5. Once they have written this information on their worksheet, they may begin the investigation
6. Completely remove the plunger from the syringe tube
7. Take a marshmallow and draw a face on it (optional). Place it into the syringe tube; it should sit flat near the bottom
8. Reinsert the plunger of the syringe until it is resting just above (but not squishing) the marshmallow
9. Block the hole in the syringe with your finger to create an airtight seal
10. Keep your finger sealed on the tip and push the plunger inward into the syringe. This may take some effort so encourage students to push firmly on the plunger
11. Watch the marshmallow carefully while it undergoes high pressure. Students should see that it shrinks, wrinkles, and shrivels up
12. Remove your finger from the tip. The air should rush out, and the marshmallow should return to its normal size
13. Reset the plunger so that it is again resting just above the marshmallow without squishing it
14. Place your finger over the hole, creating an airtight seal once more
15. Grip the plunger and pull it backward away from the marshmallow, being careful not to pull it completely out of the syringe tube
16. Watch what happens to the marshmallow should puff out and expand
17. Have students record all their observations in the designated spots on their worksheet

DISCUSSION QUESTIONS

- What happened to the marshmallow when you pulled? Pushed?
- Which condition is seen underground at SNOLAB? How do you know?
- What do you think would happen to other objects under high/low pressure?

CURRICULUM CONNECTIONS

- Language Arts: A1.2, A3.1, B1.1, B1.2
- Science & Technology: A1.1 - A1.5



UNDER PRESSURE

Name: _____

Purpose

In this activity, you will use a syringe and a marshmallow to see what happens when air pressure changes. You will push and pull the plunger of the syringe to increase and decrease the pressure inside. When you do this, carefully observe the marshmallow. This activity helps model what conditions are like deep underground at SNOLAB, where higher pressure exists because of the layers of rock above.

1

What SMART scientific question can you ask about this activity?

2

What do you think will happen to the marshmallow in this activity?

3

What variables are you measuring in this activity?

Independent variable:

Dependent variable:

Control variable(s):

4

Draw what happened to the marshmallow under **high pressure** (pushing inwards).

5

Draw what happened to the marshmallow under **low pressure** (pulling outwards).

6

What differences did you notice in the marshmallow under high and low pressure? Why do you think it happened?

7

Were your predictions correct? Explain by using your observations to support your answer.

8

How did this experiment help you see the high pressure conditions underground at SNOLAB?
