



EDUCATOR GUIDE

*Inspiring the next generation of scientists
through inquiry and discovery*

TABLE OF CONTENTS

3	<u>General information</u>
5	<u>Program at a glance</u>
7	<u>Important dates</u>
9	<u>Required materials</u>
10	<u>Lesson plans</u>
20	<u>Example submissions</u>
25	<u>Appendix</u>



PROGRAM OVERVIEW

ABOUT WONDERGROUND

Wonderground is a six-session education program developed by SNOLAB to introduce students in Grades 4-8 to the fundamentals of inquiry in STEM. Through engaging, hands-on activities, students explore the scientific method, learn to identify and define variables, and develop the skills needed to design testable experiments. The program fosters children's natural curiosity for the world around them by giving them the opportunity to create an experiment that may be chosen to be conducted at SNOLAB's underground facility in Creighton Mine. By connecting classroom learning to the unique research environment at SNOLAB, Wonderground encourages critical thinking, problem solving, and an appreciation for how scientists investigate some of science's biggest questions.

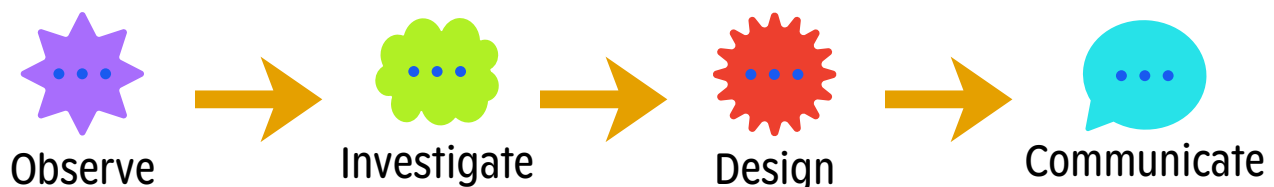
PROGRAM GOALS

Through participation in the Wonderground program, students will:

- Understand how scientists use observation, questioning, investigation, and communication to learn about the world around them.
- Ask testable questions and identify important variables in an experiment.
- Design experiments by making predictions and changing one variable at a time.
- Explore how scientists work in unique environments like SNOLAB.
- Share their ideas and findings using evidence from their experiments and logical reasoning.

WHAT TO EXPECT

Wonderground is a hands-on inquiry program where students learn by doing science. They will work through six sessions focused on asking questions, exploring variables, and designing experiments. Students will collaborate, test ideas, and revise their thinking as they go. Teachers support learning by facilitating discussion, answering questions, and providing some basic direct instruction using pre-made lessons from the SNOLAB Education & Outreach team. Overall, Wonderground emphasizes scientific reasoning and experimentation, culminating in students communicating their own experimental designs connected to SNOLAB research.





TEACHER INSTRUCTIONS

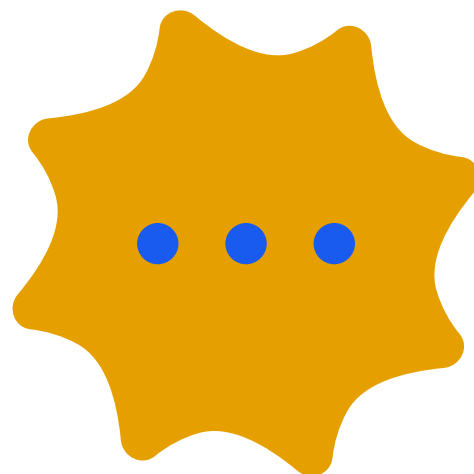
HOW TO USE THIS GUIDE

This guide is designed to support teachers in delivering the Wonderground program independently. Each of the six sessions includes clear instructions, approximate timing, required materials, Ontario curriculum connections, and assessment documents. Overall, the sessions are structured to be flexible, and can be adapted as needed to suit classroom time, student needs, and teaching style.

WHAT IS PROVIDED

Within each session, you will find:

- A session overview and learning goals
- A list of required and/or suggested materials
- A detailed lesson plan for easy delivery
- Suggested prompts and discussion questions
- Ontario provincial curriculum connections
- Assessment materials and extension activities



ADVICE FOR TEACHERS

Teachers are encouraged to help students think critically and facilitate meaningful discussions about the world of science. The goal of Wonderground is to foster curiosity and engagement with STEM content. Therefore, it is acceptable if tasks are modified and not completed exactly as written. The focus is to develop scientific reasoning through inquiry, collaboration and experimentation, rather than following this guide perfectly.

Remember that there is no single way to deliver Wonderground; what matters most is supporting students as they think and work like scientists!

PROGRAM AT A GLANCE

Session name	Brief description	Length
Introduction to the scientific method	This session aims to introduce students to the scientific method. It outlines the steps and gives students the opportunity to practice them with hands-on investigations.	45 - 60 minutes
Asking scientific questions	This session aims to teach students what a testable question is. It also allows them to understand the variables in an experiment through different activities.	45 - 60 minutes
Introduction to SNOLAB	This session introduces students to SNOLAB, providing them with some basic understanding of why certain experiments need to be conducted underground. Students also have the opportunity to see the lab through a virtual tour.	45-60 minutes
SNOLAB & the scientific method	This session reinforces students' knowledge of the conditions at SNOLAB that allow scientists to perform unique experiments underground. It also reviews variables with the help of more hands-on investigations.	~45 minutes
Designing your experiment	This session helps students design their own experiment that they would like to be completed using SNOLAB's unique lab conditions. It reviews testable questions, hypotheses, and variables to support their submissions.	~30 - 45 minutes
Sharing your science	This final session gives students the opportunity to communicate various science facts in different ways. They are introduced to the basics of data analysis and learn how to present that data to different audiences.	~30 - 45 minutes



CONTENT DELIVERY METHODS

1) ASYNCHRONOUS (TEACHER-LED)

Teachers **independently deliver** the Wonderground program using the provided lesson plans and resources, with support from the Education & Outreach team available by email as needed. This flexible option is well suited for out-of-province, remote, or multilingual classrooms. This option may still include an optional virtual tour during Session 3 with advanced coordination.

2) HYBRID (MIX OF TEACHER AND SNOLAB-LED)

Teachers select which Wonderground sessions they would like to deliver using the provided teacher's guide and classroom resources. The Education & Outreach team would typically facilitate the SNOLAB-specific content (sessions 3 and 4) virtually, with the option to support additional sessions upon request. An optional virtual tour may also be included, and ongoing support is available via email or during the live sessions.

3) SYNCHRONOUS (SNOLAB-LED)

All Wonderground content is delivered live by the Education & Outreach team, either **in-person** (for Sudbury area classes only) or **virtually**, allowing students to engage directly with SNOLAB staff throughout the program. Teachers receive the program guide and supporting resources in advance and assist with classroom facilitation, while students participate in interactive discussions and activities.

A) SIX-DAY OPTION

Sessions are delivered on six consecutive school days, allowing for a deep-dive into the Wonderground program content.

B) SIX-WEEK OPTION

Sessions are delivered once per week over six weeks, allowing for a more flexible schedule of Wonderground content delivery.

Please email outreach@snolab.ca with your preferred delivery method.

*Limited spots available for both hybrid and synchronous delivery.
Priority will be given to equity deserving groups*

TIMELINE: 2026-2027

OCT 12, 2026

Wonderground
program delivery

Experiment
submission opens

Wonderground
program delivery

JAN 29, 2027

Experiment
submission closes

Submission
review & selection

**CELEBRATION
OF LEARNING**

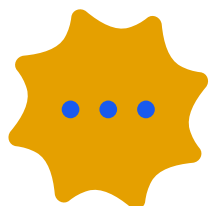
Experiment results
and program wrap-up
(More information on pg. 8)



CELEBRATION OF LEARNING

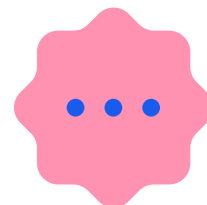
EVENT DESCRIPTION

At the completion of the Wonderground program, all participating classes will be invited to take part in a hybrid celebration of the learning. This will include a look at all the selected experiments from the program and their results. It is a great opportunity to meet and connect with other program participants. This unique event is offered as a hybrid delivery in order to allow for schools across the country to participate. The event includes speakers from SNOLAB and fun activities for students. More details will be communicated directly to participating educators.



SAVE THE DATE

Spring 2027 - Date TBC



*Picture from pilot program year's (2026) Celebration of Learning



MATERIALS

MATERIALS

The materials you may need for the six-session program are:

- 1 Clear bin (large)
- Pencils
- Raisins
- Carbonated water
- Chart paper
- Laptop
- Projector and/or SMART board
- Pylons or cones
- Hula hoop
- Bean bags
- Kettle
- Thermometer
- Timer
- 3-5 opaque boxes (small)
- A variety of small items
- Paper towels
- Graph paper
- Dice
- Eggs
- Table salt
- Clear cups or small containers
- Rulers or measuring tapes
- Measuring spoons
- Stir sticks
- Small marshmallows
- Syringes
- Student technology (tablets or computers)
- Worksheets and assessments from SNOLAB
- Calculators
- 11" x 17" paper or cardstock
- Letter-sized printer paper (or scrap paper)
- Pencil crayons
- Markers
- Speakers or reliable sound system
- Printed SNOLAB charade cards
- Supplemental resources (see appendix)

If you are missing and/or unable to find any of the above listed materials, please feel free to contact Education & Outreach to inquire about sending you what is missing!



SESSION 1: THE SCIENTIFIC METHOD

~45 - 60 minutes

SESSION OVERVIEW

In this session, students are introduced to the scientific method and examine how scientists use it to investigate questions about the world. Through observation and investigation, they learn why each step is important for real-life scientific inquiries. Lastly, students will put their knowledge to the test by conducting simple and engaging scientific activities.

LEARNING GOALS

- **Identify** and describe the steps of the scientific method
- **Explain** why each step of the scientific method is important
- **Ask** questions about science and make logical predictions
- **Investigate** simple experiments using the scientific method
- **Observe** scientific phenomena and to make conclusions
- **Share** findings using appropriate scientific vocabulary



Investigate



Observe

SCIENTIFIC BACKGROUND

The scientific method is a six-step process that serves as the basis for all scientific inquiries. It uses a structure that involves asking questions, making predictions, performing tests, recording observations, analysing data, and communicating results. Scientists at SNOLAB use these same principles to answer some of the world's most mysterious questions. As a result, the scientific method is a vital part of science education for students of all ages.

CURRICULUM CONNECTIONS

Science & Technology

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

Language Arts

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

Mathematics

- Grade 4: E2.2 & Grade 5-6: E2.1

*The Arts

- Grade 4-8: D2.1, D2.3, D3.1

* Indicates an extension activity connection



SESSION 1: THE SCIENTIFIC METHOD

~45 - 60 minutes

MATERIALS

- Session 1 presentation
- Introduction survey link
- Student tech (for survey)
- 1 clear container filled with water
- 1 wood pencil
- Raisins
- Carbonated (soda) water
- Laptop
- SMART board or projector

DISCUSSION PROMPTS

Before

- What predictions or questions can we make about this activity?
- What might happen if we drop this pencil in the bucket of water? Why?
- Do you think the carbonated water will make the raisins float or sink? Why?

During

- What do you notice about the pencil in the water?
- What happened to the raisins in the carbonated water?
- Why do we need to repeat the test at least 3 times?

After

- How did what you observe compare to your hypothesis (prediction)? Why or why not?
- Is the experiment a fail if your hypothesis was wrong? Explain.
- What other liquids do you think a pencil/raisin would float in?

EXTENSIONS & ASSESSMENT

STEM focused: Mystery box challenge

- Students investigate and make predictions about what is in a mystery box

Cross-curricular: Picture detectives (Art)

- Students use the scientific method to observe a SNOLAB experiment picture

Assessment: Session 1 Exit ticket

See the appendix for more details on this section



SESSION 2: ASKING SCIENTIFIC QUESTIONS

~45 - 60 minutes

SESSION OVERVIEW

In this session, students learn how scientists turn curiosity into investigations by asking focused and testable questions. They also explore independent, dependent, and control variables through hands-on activities. Students also learn to modify their scientific questions so that they follow the SMART framework, which provides them with the foundation for designing good experiments in future sessions.

LEARNING GOALS

- **Identify** different variables in an experiment
- **Explain** the importance of controlling certain variables
- **Differentiate** between a testable and non-testable scientific questions
- **Design** good scientific questions using the SMART framework
- **Investigate** different variables to understand how they affect an experiment



Investigate



Design

SCIENTIFIC BACKGROUND

Science begins with curiosity, but good investigations start with a testable question. Scientists design good tests by changing one variable, measuring what happens, and keeping other variables the same. Learning to identify variables and ask SMART scientific question helps students plan investigations and collect meaningful evidence. These same skills are used by scientists at SNOLAB to investigate some of the world's biggest physics questions.

CURRICULUM CONNECTIONS

Science & Technology

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

Language Arts

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

*Mathematics

- Grade 4: E2.2 & Grade 5-6: E2.1

*Health & Physical Education

- Grade 4-8: B1.1, B3.1, C1.2, C1.3, C1.4

* Indicates an extension activity connection

SESSION 2: ASKING SCIENTIFIC QUESTIONS

~45 - 60 minutes

MATERIALS

- Session 2 presentation
- Small boxes with small items inside
- Various small items (eraser, marble, etc)
- Metre sticks or measuring tapes
- Toy cars
- Cardboard pieces (for ramps)
- Laptop
- SMART board or projector

DISCUSSION PROMPTS

Before

- Can every question be answered with an experiment? Why or why not?
- What is something in science that you wonder about?
- How do scientists know if what they observed is actually true?

During

- What did you change? What did you keep the same?
- What did you notice when you changed one of the variables?
- How did changing more than one variable (adding a second object) make it harder?

After

- What did you learn about variables today?
- Why is it important to change only one variable at a time?
- What new questions are you curious about? Are they SMART?

EXTENSIONS & ASSESSMENT

STEM focused: Egg buoyancy experiment

- Students investigate how salt water affects how well an egg floats

Cross-curricular: Changing variables hula hoop toss (Phys. Ed)

- Students explore changing variables with an activity using bean bags and a hula hoop

Assessment: Session 2 Exit ticket

See the appendix for more details on this section



SESSION 3: INTRO TO SNOLAB

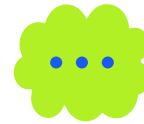
~45-60 minutes

SESSION OVERVIEW

In this session, students are introduced to SNOLAB, where scientists work to answer some of the scientific questions about the world around us. They are given a brief overview of the various conditions in the underground lab that make it a unique spot to perform complicated experiments. Finally, students can participate in a live virtual tour from the SNOLAB team!

LEARNING GOALS

- **Understand** why SNOLAB is located deep underground
- **Investigate** the unique conditions seen in the lab
- **Observe** the research taking place at SNOLAB
- **Ask** SMART scientific questions about real-world science
- **Build** curiosity and an appreciation for science



Investigate



Observe

SCIENTIFIC BACKGROUND

Some of the biggest questions in science cannot be answered in a typical laboratory setting. At SNOLAB, scientists use a unique underground environment and specialized technology to reduce background noise and detect rare space particles. By exploring how and why this research happens, students will discover how scientists investigate some of our universe's biggest mysteries.

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: D1.1, D1.3, D1.4, D2.2, D2.4

*Language Arts

- Grade 4-8: D1.2, D1.4, D2.1, D2.6, D3.1, D3.2

*Mathematics

- Grade 4-5: C4, D1.2, D1.3, D1.6, D2.1
- Grade 6-8: B2.1, B2.12, C4, D1.1 - D1.3, D1.6, D2.1

* Indicates an extension activity connection



SESSION 3: INTRO TO SNOLAB

~45-60 minutes

MATERIALS

- Session 3 presentation
- Laptop
- SMART board or projector
- Speakers or sound system
- Optional: SNOLAB handout

Note: To include a live virtual tour in this session you must reach out to SNOLAB Education & Outreach in advance to schedule a date and time.

DISCUSSION PROMPTS

Before

- Have you ever heard of SNOLAB? What do you know about it?
- Is there anything about space or the universe that you are curious about?
- If you were a scientist, what would you want to study?

During

- What do you notice about the underground laboratory?
- Was SNOLAB what you expected a science lab to look like?
- Why is SNOLAB built deep underground? How does that help scientists?

After

- What is one thing that you learned?
- If you could investigate one thing at SNOLAB, what would it be and why?
- What new questions do you have after seeing SNOLAB and its experiments?

EXTENSIONS & ASSESSMENT

STEM focused: Finding a signal in the noise activity

- Students explore the rare particle events seen at SNOLAB through a Math game

Cross-curricular: SNOLAB poster contest (Art)

- Students showcase their learning by creating a poster about the science at SNOLAB

Assessment: Session 3 Exit ticket

See the appendix for more details on this section

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 5: DESIGNING YOUR EXPERIMENT

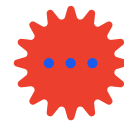
~30-45 minutes

SESSION OVERVIEW

In this session, students will take on the role of scientists by designing an experiment that could be performed at SNOLAB. Using their knowledge of underground conditions and scientific inquiry, students will develop a research question, identify important variables, make logical predictions, and highlight what information they will require to answer their question.

LEARNING GOALS

- **Develop** a SMART scientific question that can be tested with an experiment
- **Brainstorm** ideas with their peers
- **Use** the steps of the scientific method to **design** an experiment
- **Communicate** their ideas clearly using proper scientific vocabulary
- **Present** their experiment using the provided graphic organizer



Design



Communicate

SCIENTIFIC BACKGROUND

Scientists use inquiry, evidence, and careful planning to investigate questions about the world around them. Designing a successful experiment requires identifying variables, making predictions, and considering how experimental conditions influence results. Students will apply these skills to create an investigation inspired by the unique environment at SNOLAB.

CURRICULUM CONNECTIONS

Science & Technology

- Grade 4-8: A1.1 - A1.5, A3.1

Language Arts

- Grade 4-8: A1.2, A3.1, B1.1 - B1.3, D1.4, D2.1

SESSION 5: DESIGNING YOUR EXPERIMENT

~30-45 minutes

MATERIALS

- Session 5 presentation
- Laptop
- SMART board or projector
- Submission form (online or printed)
- Brainstorming worksheet

DISCUSSION PROMPTS

Before

- What makes a good scientific question?
- What questions do you have about science using a unique condition at SNOLAB that could be tested?
- What challenges might you need to consider for your underground experiment?

During

- What is your experiment trying to discover or understand?
- What are the variables in your investigation? What are you controlling?
- What evidence would you need to collect to answer your scientific question?

After

- What makes your experiment a good fit for SNOLAB?
- What was the most important decision you made when designing your experiment?
- How did your understanding of SNOLAB's unique conditions change your design?

EXTENSIONS & ASSESSMENT

Extension

- No extensions are required for this session. Students may continue to refine their experiment ideas and proposals based on feedback and further discussion

Assessment

- Student experiment submissions will be reviewed based on their ability to develop a scientific question, apply knowledge of SNOLAB's unique conditions, and communicating their experimental design

See the appendix for more details on this section



SUBMISSION REQUIREMENTS

WHAT WE ARE LOOKING FOR

Criterion	What SNOLAB is looking for
Quality of the question (SMART)	The experiment is based on a clear, specific, measurable, achievable, relevant, and testable scientific question.
Scientific thinking	The submission demonstrates logical reasoning, identifies variables where appropriate, and shows an understanding of the scientific method.
Use of SNOLAB's unique conditions	The experiment incorporates one or more of SNOLAB's unique conditions (e.g. reduced cosmic radiation, increased pressure, ultra pure water, etc.).
Creativity	The experiment presents an original or engaging idea while remaining scientifically appropriate.
Feasibility	The experiment can realistically be completed within the available time, space, equipment, cost, and program constraints.
Safety	The experiment can be conducted safely using appropriate materials, equipment, and procedures at SNOLAB and/or in the classroom.

REVIEW PROCESS

Upon receipt by SNOLAB, student experiment submissions will be reviewed by the Education & Outreach team to identify ideas that demonstrate curiosity, scientific thinking, and potential for investigation. Submissions do not need to be perfect or fully developed; scientists will work with students to refine their ideas, address challenges, and further develop their experiments. The review process is intended to support students in experiencing the true nature of the scientific method, where real-life ideas are discussed, reviewed, and edited to be more clear and achievable.

EXAMPLE SUBMISSION: GRADES 4-6

ORIGINAL SUBMISSION

Experiment name:	The SNOLAB expert	Grade level:	6
Question:	Does deep underground air pressure (simulated by a syringe) squash the air bubbles inside a soft object?		
Hypothesis:	Since SNOLAB is 2 km underground where the air is heavier, if I simulate that pressure using the syringe, then the soft object will shrivel up.		
What information is needed:	-Measure the soft object with a ruler before and after -Record "starting volume" and "compressed volume" of air -What do you notice about the marshmallow's shape under pressure?		
Cost:	Syringe: \$6.62		
	Marshmallows: \$2.77		

Student submissions are reviewed by SNOLAB scientists and feedback is provided to help solidify their idea!

This experiment was adapted to be done underground instead of simulated in a syringe!



FINAL RESULTS



The **height and diameter of 10 marshmallows** were measured on surface and underground at SNOLAB.

They found that the **increased pressure** underground **reduced** the overall size of the marshmallows.



EXAMPLE SUBMISSION: GRADES 7-8

ORIGINAL SUBMISSION

Experiment name: WIB (Will It Bounce) **Grade level:** 7

Question: How does a basketball bounce on surface compared to underground?

Hypothesis: We think that the ball will bounce lower underground.

What information is needed:

-How high the basketball bounces

Materials: -Basketball

-Pressure sensor

-Ball pump

-Tape measure

-Slow motion camera

The question does not have to be complicated, as long as it is well thought out and testable, it will be considered.

This experiment compared how underground conditions affect the properties of a common object.



FINAL RESULTS



The basketball was pumped and **dropped from the same height** on surface and underground.

They found that the basketball **bounced lower underground** because the pump could not inflate the ball as much with the **higher pressure**.





SESSION 6: SHARING YOUR SCIENCE

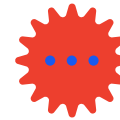
~30 minutes

SESSION OVERVIEW

In this session, students will explore the many ways scientific ideas can be communicated to different audiences. Using their creativity, students will communicate a variety of science facts through different mediums, such as art, song, speech, and acting. Through this experience, they will discover that scientists use a range of communication methods to share discoveries, build understanding, and inspire curiosity, while adapting their message to make it accessible and engaging for their audience.

LEARNING GOALS

- **Communicate** science in a clear and engaging way
- **Choose** the best way to explain a science fact to an audience
- **Explain** a science fact using a method of their choice
- **Design** ideas with their group
- **Understand** why science communication is important
- **Listen** to the ideas of their peers



Design



Communicate

SCIENTIFIC BACKGROUND

Science communication is an important part of the scientific method. Scientists use many different methods to share their ideas and discoveries, choosing communication styles that are appropriate for their audience. By communicating science through creative formats, students practice making science ideas accurate, engaging, and accessible to others.

CURRICULUM CONNECTIONS

Science & Technology

- Grade 4-8: A1.5, A3.2

Language Arts

- Grade 4-8: A1.1, A3.1, B1.1 - B1.5

The Arts

- Grade 4-6: A1.3, B1.1, B1.3, C1.3, D1.1, D1.3
- Grade 7-8: A1.4, B1.1, B1.3, C1.3, D1.1, D1.3

SESSION 6: SHARING YOUR SCIENCE

~30 minutes

MATERIALS

- Session 6 presentation
- Laptop
- SMART board or projector
- Science fact cards (see appendix)
- Sharing your science handout
- Student tech (for exit survey)
- Art materials (play-doh, paper, pencils, markers, etc.)

DISCUSSION PROMPTS

Before

- Why is it important for scientists to share their discoveries with others?
- Why might a scientist choose one way of communicating over another?
- How could you explain something you learned to someone younger than you? Older?

During

- Who are you presenting your science fact to? Who is your audience?
- How could you make sure that this audience understands what you are presenting?
- What message do you want your audience to remember when you are done?

After

- Are there other methods that could have worked better to present your idea?
- What challenges did your group have during this communication activity?
- Did any of these methods make you more curious about the world around you?

EXTENSIONS & ASSESSMENT

Extension

- No extensions are required for this session. Students can continue practicing their communication skills by choosing alternative methods to share their science ideas.

Assessment

- Assessment for this session is mainly through student product and observation. There is also an optional final Wonderground assessment, which can be viewed in the appendix of this document.



APPENDIX

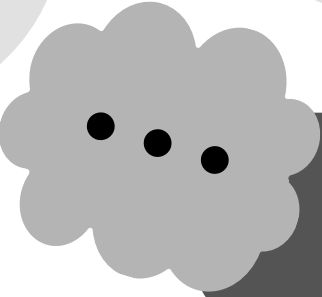
The following pages contain all supplemental resources for Wonderground program delivery!



SESSION 1

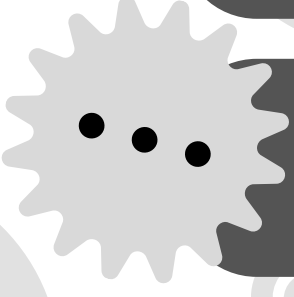
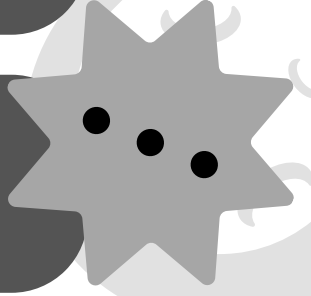
- Printable classroom poster - Scientific Method
- The Scientific Method Exit Ticket (Grade 4 - 6)
- The Scientific Method Exit Ticket (Grade 7 - 8)
- The Scientific Method Worksheet Answer Keys
- Extension Activity: Mystery box challenge (optional)
- Extension Activity: Picture detectives (optional)

THE SCIENTIFIC METHOD



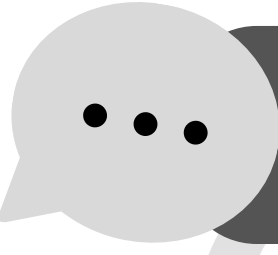
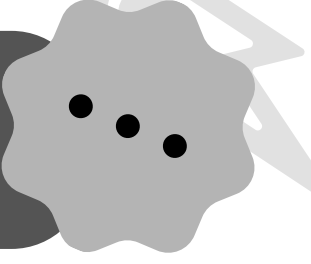
Step 1: Ask a question

Step 2: Make a prediction



Step 3: Test the prediction

Step 4: Look at the results



Step 5: Share your results





THE SCIENTIFIC METHOD

Name: _____

1

Put the steps of the scientific method in order from 1 to 5

Share your results _____
Ask a question _____
Test the prediction _____
Make a prediction _____
Look at the results _____

2

Match the step with the correct example

Will raisins float in carbonated water?

I think the raisins will float will in carbonated water.

Drop raisins in water and watch for 10-15 seconds.

The raisins floated in the carbonated water.

They floated because the bubbles lifted them.

Test the prediction

Ask a question

Make a prediction

Share your results

Look at the results

3

A student wants to find out if ice cubes will melt faster in cold or warm water.

a) What is a question they could ask?

b) What prediction could they make?



THE SCIENTIFIC METHOD

Name: _____

1

A group of students is wondering whether listening to slow music affects how quickly they can complete a puzzle. Complete the five steps of the scientific method for this investigation.

Ask a question: _____

Make a prediction: _____

Test your prediction: _____

Look at your results: _____

Share the results: _____

2

If a scientist makes a prediction that turns out to be wrong, does that mean their experiment failed? Explain your answer.



THE SCIENTIFIC METHOD

Name: Total: 14 points

1

Put the steps of the scientific method in order from 1 to 5

Share your results	<u>5</u>
Ask a question	<u>1</u>
Test the prediction	<u>3</u>
Make a prediction	<u>2</u>
Look at the results	<u>4</u>

5 points

2

Match the step with the correct example

5 points

Will raisins float in carbonated water?	Test the prediction
I think the raisins will float will in carbonated water.	Ask a question
Drop raisins in water and watch for 10-15 seconds.	Make a prediction
The raisins floated in the carbonated water.	Share your results
They floated because the bubbles lifted them.	Look at the results

3

A student wants to find out if ice cubes will melt faster in cold or warm water.

a) What is a question they could ask?

Answers may vary. EXAMPLE: Does water temperature
affect how fast an ice cube melts?

b) What prediction could they make?

Answers may vary. EXAMPLE: I think the ice cube in
the warm water will melt faster.

4 points (2 each)



Name: Total: 13 points

THE SCIENTIFIC METHOD

1

A group of students is wondering whether listening to slow music affects how quickly they can complete a puzzle. Complete the five steps of the scientific method for this investigation.

Ask a question: Answers may vary. EXAMPLE: Does listening to slow music affect how fast someone can solve a puzzle?

Make a prediction: Answers may vary. EXAMPLE: I think that it will take more time to solve the puzzle when listening to music.

Test your prediction: Answers may vary. EXAMPLE: Use a timer to see how long it takes multiple people to solve the same puzzle.

Look at your results: Answers may vary. EXAMPLE: The people who listened to music were slower at solving the puzzle.

Share the results: Answers may vary. EXAMPLE: Listening to music slowed them down because the brain relaxes too much.

10 points (2 each)

2

If a scientist makes a prediction that turns out to be wrong, does that mean their experiment failed? Explain your answer.

No, it does not mean their experiment failed because the results they obtained were still valid. The results just proved that what they predicted was incorrect, so they have learned something new regardless.

3 points



MYSTERY BOX CHALLENGE

MATERIALS

- Opaque containers or boxes with lids (enough for groups 3-5 students)
- A variety of small items to place inside (paper clips, marbles, etc.)
- Writing utensils
- "What's in the box?" worksheet
- Optional: Two-pan balances, measuring tapes/rulers, magnets

INSTRUCTIONS

1. Divide students into groups of 3 - 5 students (smaller groups is better)
2. Provide each group with a sealed mystery box or container. Students are not allowed to open the container or box until they are told to do so (at the end of the activity)
3. Instruct students that their goal is to figure out what is inside the box using only observations and evidence
4. Allow students to investigate the box's contents using different methods like shaking it, tilting it, feeling its weight, and comparing it to other boxes
5. Ask students to record their observations on their worksheet before making any conclusions
6. Have students discuss within their group what they think is inside the box and form an initial hypothesis
7. Allow students to test their hypothesis by performing additional observations (i.e. comparing movement between boxes or retesting sounds and weights)
8. Give groups time to revise their hypotheses if new evidence changes their thinking
9. Once groups are confident in their conclusion, have them share what they think is in the box and explain what evidence led them to make that conclusion
10. Reveal the contents of each box and compare results to student predictions

DISCUSSION QUESTIONS

- What observations helped you make your predictions?
- Did your hypothesis change as you gathered more evidence?
- What strategies did your group use to gather better evidence?
- What does this activity tell us about how scientists work when they cannot directly see what they're studying?
- How did the scientific method help you throughout this activity?

CURRICULUM CONNECTIONS

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



WHAT'S IN THE BOX?

Name: _____

1

Examine your box without opening it and record your observations in the space below.

2

Using your observations, what do you think is in the box?

3

What tests did you perform to test your prediction?

4

Did your prediction change after doing tests? If yes, write it below.

5

Was your prediction right? What was in the box?



PICTURE DETECTIVES

MATERIALS

- A SNOLAB image from their website (showing an experiment, part of the underground lab, etc.)
- Projector or SMART board (to display the image for students to view)
- Picture detectives worksheet
- Writing utensils
- Chart paper or whiteboard (for whole-group discussion)

INSTRUCTIONS

1. Briefly discuss with students that scientists are always observing their surroundings and that for them to answer the world's questions, they first need to collect evidence. End this brief discussion with a review of observation versus inference and provide them with a simple example (i.e. an observation is that there are tracks on the ground; an inference is that something moved across the surface)
2. Display the chosen SNOLAB image for 30-60 seconds
3. Ask students to observe silently and carefully. Encourage them to look for objects, patterns, colours, shapes, anything unusual, and/or movement.
4. Remove or hide the image when time is up
5. Give students a few minutes to independently record their observations on the worksheet provided
6. When students are finished, invite them to share their observations and inferences
7. On the board/chart paper, record students' observations, questions, and inferences
8. Discuss whether each idea is an observation or an inference
9. Put the image back on the screen and give students time to observe it a second time
10. Ask students to compare their new observations to their notes and discuss what was similar and different

DISCUSSION QUESTIONS

- What was easier: making observations or making inferences?
- Did everyone notice the same details?
- Why is it important to separate observations from inferences?
- What additional information helped you better understand the image?
- How did this activity relate to the scientific method? What steps were used?

CURRICULUM CONNECTIONS

- Language Arts: A1.2, A3.1, B1.1, B1.2
- Science & Technology: A1.1 - A1.5
- The Arts: D2.1, D2.3, D3.1



PICTURE DETECTIVES

Name: _____

1 Record your initial observations in the space below.

2 What questions do you have about the picture?

3 What inferences can you make about the picture?

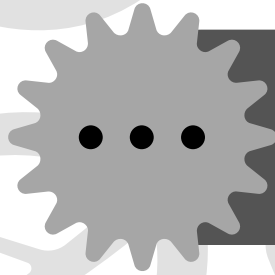
4 Record any new observations in the space below.



SESSION 2

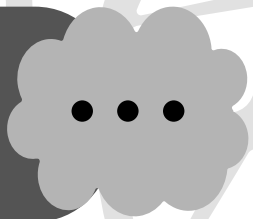
- Printable classroom poster - How to ask SMART questions
 - Printable classroom poster - Know your scientific variables
 - Asking Scientific Questions Exit Ticket (Grade 4 - 6)
 - Asking Scientific Questions Exit Ticket (Grade 7 - 8)
 - The Scientific Questions Worksheet Answer Keys
 - Extension Activity: Egg Buoyancy experiment (optional)
 - Extension Activity: Changing variables hula hoop toss (optional)
- 

HOW TO ASK SMART QUESTIONS



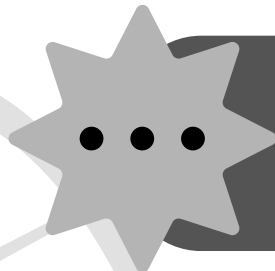
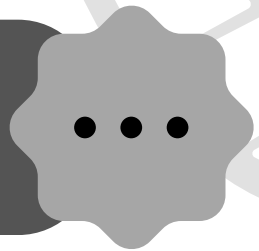
SPECIFIC

M EASURABLE



A CHIEVABLE

RELEVANT



TIMELY



KNOW YOUR SCIENTIFIC VARIABLES



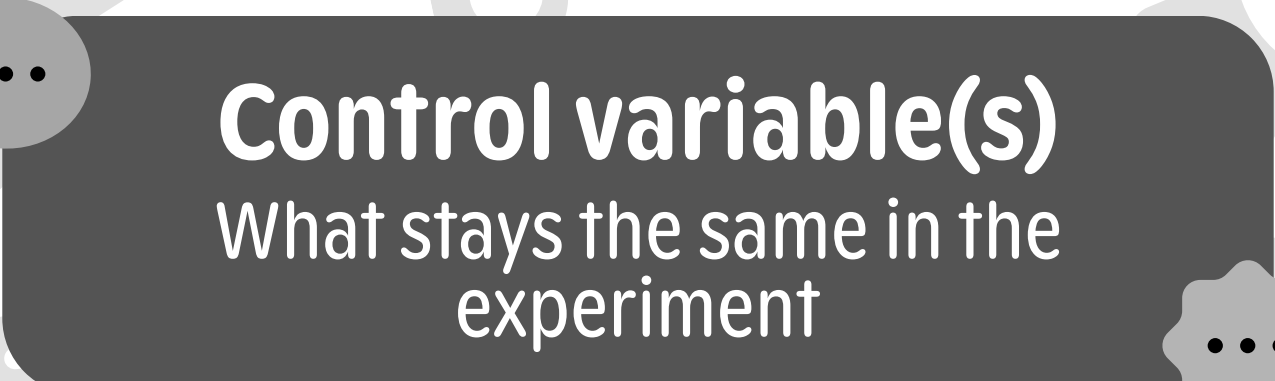
Independent variable

What is changing in the experiment



Dependent variable

What is measured in the experiment



Control variable(s)

What stays the same in the experiment



ASKING SCIENTIFIC QUESTIONS

Name: _____

1

A student wants to find out if sunlight affects plant growth. Match the variables below with the correct type.

Plant height

Independent (what is changing)

Amount of sunlight

Dependent (what is being measured)

Type of plant used

Control (what is staying the same)

2

Is this a SMART scientific question? Circle YES or NO.

a) Which pet is the best?

YES NO

b) Does temperature affect how fast ice melts?

YES NO

c) Is chocolate delicious?

YES NO

3

The question below is not a good scientific question. Rewrite it so it can be tested. (Hint: Use SMART to help you).

Which toy car is the best?



ASKING SCIENTIFIC QUESTIONS

Name: _____

1

A student is investigating if the temperature of water affects how quickly sugar dissolves. Identify the variables the student will need to complete the experiment.

Independent (what is changing): _____

Dependent (what is measured): _____

Control (what is staying the same): _____

2

Is this a SMART scientific question? Circle YES or NO and briefly explain why.

a) Are dogs better than cats?

YES

NO

Reason: _____

b) Which paper towel brand is the most absorbent?

YES

NO

Reason: _____

3

Choose one of the prompts and design your own investigation.

Paper airplane flight time **OR** Ball bounce height

SMART question: _____

Independent variable: _____

Dependent variable: _____

Control variable(s): _____



Name: TOTAL: 8 points

ASKING SCIENTIFIC QUESTIONS

1

A student wants to find out if sunlight affects plant growth. Match the variables below with the correct type.

Plant height ~~Independent (what is changing)~~
Amount of sunlight ~~Dependent (what is being measured)~~
Type of plant used Control (what is staying the same)

3 points

2

Is this a SMART scientific question? Circle YES or NO.

3 points

a) Which pet is the best?

YES ☒ NO

b) Does temperature affect how fast ice melts?

☒ YES NO

c) Is chocolate delicious?

YES ☒ NO

3

The question below is not a good scientific question. Rewrite it so it can be tested. (Hint: Use SMART to help you).

Which toy car is the best?

Answers may vary. EXAMPLE: Which toy car is the
fastest at going down a ramp?

2 points



Name: TOTAL: 11 points

ASKING SCIENTIFIC QUESTIONS

1

A student is investigating if the temperature of water affects how quickly sugar dissolves. Identify the variables the student will need to complete the experiment. 3 points

Independent (what is changing): Water temperature

Dependent (what is measured): Time to dissolve sugar

Control (what is staying the same): Amount of water, stirring, etc.

2

Is this a SMART scientific question? Circle YES or NO and briefly explain why. 4 points

a) Are dogs better than cats?

YES **NO**

Reason: Requires an opinion, so it is not testable.

b) Which paper towel brand is the most absorbent?

YES NO

Reason: Abides by the SMART acronym, so it's testable.

3

Choose one of the prompts and design your own investigation.

Paper airplane flight time OR Ball bounce height

4 points

SMART question: Does the type of paper affect how far a paper airplane flies?

Independent variable: Type of paper

Dependent variable: Distance (cm)

Control variable(s): Starting point, throwing angle/speed, etc.



EGG-CELLENT SCIENCE

MATERIALS

- Raw eggs
- Table salt
- Clear cups or bowls
- Water
- Tablespoons or measuring cups
- Stir sticks or spoons
- Paper towels
- Egg-cellent science worksheet
- Optional: Tray or tub for spills
- Rulers or measuring tapes

INSTRUCTIONS

1. Briefly discuss the different types of variables in a scientific investigation and review the importance of writing SMART scientific questions
2. Divide students into groups of 3-5 and distribute all materials to each group.
3. Give students a few minutes to discuss what questions they could investigate about how salt affects an egg's ability to float, their predictions, and the experiment's variables.
4. Once all group members have completed their planning, they may begin the investigation.
5. Fill two clear cups or bowls with equal amounts of water (this is a control variable).
6. Add 1-2 tablespoons of table salt to one of the cups and stir until it is completely dissolved.
7. Gently place the egg into the cup with plain water (no salt).
8. Observe for 30 seconds and record observations on the worksheet.
9. Use a ruler or measuring tape to measure the distance between the bottom of the container and the egg. Record the measurement.
10. Carefully remove the egg and dry it with a paper towel.
11. Place the egg into the saltwater solution.
12. Observe for 30 seconds and record observations.
13. Repeat the experiment using different amounts of salt, recording the amount each time.
14. Students discuss in their groups about what they observed, why they think it happened, how it relates to variables, and how changing the salt affected the egg's ability to float.
15. Gather as a class and discuss the experiment, focusing on what students observed and how it relates to changing variables in an experiment.

DISCUSSION QUESTIONS

- Did the egg sink, float, or partially float in each cup?
- What differences between the two cups did you observe?
- What were the variables?
- Why is it important to change only one variable at a time?

CURRICULUM CONNECTIONS

- Language Arts: A1.2, A3.1, B1.1, B1.2
- Science & Technology: A1.1, A1.2, A1.3, A1.4, A1.5



EGG-CELLENT SCIENCE!

Name: _____

1 What SMART scientific question are you answering in this experiment?

2 What do you predict will happen during the experiment? Use your question to help you.

3 What variables are being tested?

Independent: _____

Dependent: _____

Control: _____

4 Record your measurements below.

Water: _____

Salt water: _____

5 Are the results of the experiment what you predicted? Why or why not?



Session 2 Extension

VARIABLE BEAN BAG TOSS

MATERIALS

- Hula hoop
- Bean bags
- Open space (either outside or gym)
- Cones or pylons (if outside)

INSTRUCTIONS

1. Place a hula hoop about 2 - 3 metres away from the starting point (either a line on the gym floor or a pylon/cone outside)
2. Instruct students to line up in a single file line behind the starting point
3. Before beginning, ask students to make prediction about how many bean bags they think will land inside the hula hoop
4. One at a time, students take turns tossing a bean bag towards a hula hoop using an underhand toss. Students are trying to get their bean bag into the hoop target
5. Once all students have a turn, count the number of bean bags that made it into the hoop
6. Ask students to predict what they think will happen if one variable is changed, such as the distance between the starting point and the hula hoop
7. Repeat the activity after changing one variable and count the number of successful throws
8. Discuss how changing the single variable affected the outcome and compare the results to the first round
9. Ask students to predict what will happen if multiple variables are changed at the same time
10. Repeat the activity while changing two or more variables (i.e. further increase the distance and have students throw with their non-dominant hand)
11. Count the number of successful throws
12. Compare the results from all rounds and discuss whether it is easier to determine the cause of a change in results when only one variable is changed at a time

EXAMPLE VARIABLES TO CHANGE

- Increase/decrease distance between hula hoop and starting point
- Have students toss the bag with their non-dominant hand
- Have students spin around 1-2 times before tossing the bean bag
- Any combination of the above

DISCUSSION QUESTIONS

- What happened when multiple variables were changed at once?
- Was it easy to determine which variable affected the outcome?
- What other variables could we test? What might happen if we tested it?

CURRICULUM CONNECTIONS

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



SESSION 3

- Introduction to SNOLAB Exit Ticket (Grade 4 - 6)
 - Introduction to SNOLAB Exit Ticket (Grade 7 - 8)
 - Introduction to SNOLAB Worksheet Answer Keys
 - Extension Activity: SNOLAB poster activity (optional)
 - Extension Activity: Signal seekers (optional)
- 



INTRODUCTION TO SNOLAB

Name: _____

1

What is SNOLAB? Circle the best answer.

- a) A zoo for rare animals
- b) An underground science lab where scientists study tiny particles
- c) A weather station in Northern Ontario that tracks snow
- d) A hospital for astronauts

2

Why is SNOLAB underground? Circle all the right answers.

- To keep workers warm
- To block space particles
- To make experiments with better results
- It costs less money to do science underground
- To stop radiation from the surface

3

Why do scientists at SNOLAB need to shower before going into the lab?

4

Draw and label two pieces of personal protective equipment (PPE) that needs to be worn underground.



INTRODUCTION TO SNOLAB

Name: _____

1 SNOLAB is a science lab located 2 km underground. Explain one reason why this location is useful for research.

2 Match the unique SNOLAB condition to the example by drawing a line between them.

Higher pressure

Scientists pass through an air shower and change their clothing before entering the lab.

Fewer cosmic rays

A detector can observe rare particle interactions without interference from space signals.

Class 2000 cleanliness

Nearly 2 km of rock sits above the lab, pressing on the surrounding rock and structure.

3 Identify two pieces of personal protective equipment (PPE) and briefly explain why they are important during underground travel.

PPE #1:

PPE #2:

Explanation:

Explanation:

INTRODUCTION TO SNOLAB**1** What is SNOLAB? Circle the best answer.

- a) A zoo for rare animals
- ☒ b) An underground science lab where scientists study tiny particles
- c) A weather station in Northern Ontario that tracks snow
- d) A hospital for astronauts

1 point

2 Why is SNOLAB underground? Circle all the right answers.

To keep workers warm 3 points

☒ To block space particles☒ To make experiments with better results☐ It costs less money to do science underground☒ To stop radiation from the surface**3** Why do scientists at SNOLAB need to shower before going into the lab?

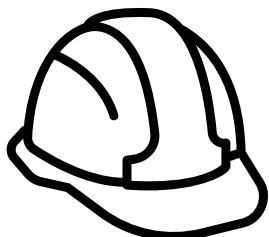
They need to shower to get rid of the dust and particles from the mine that may have got on their skin and clothes on the way underground, which keeps the lab super clean.

2 points

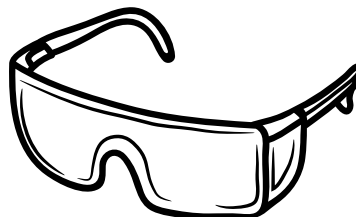
4 Draw and label two pieces of personal protective equipment (PPE) that need to be worn underground.

Answers may vary. See example below.

2 points



Hard hat



Safety goggles



Name: TOTAL: 9 points

INTRODUCTION TO SNOLAB

1 SNOLAB is a science lab located 2 km underground. Explain one reason why this location is useful for research.

Answers may vary. EXAMPLE: SNOLAB is located underground because the deep layers of rock filter out certain space particles, so that scientists can study specific ones like neutrinos.

2 points

2 Match the unique SNOLAB condition to the example by drawing a line between them.

Higher pressure

Scientists pass through an air shower and change their clothing before entering the lab.

Fewer cosmic rays

A detector can observe rare particle interactions without interference from space signals.

Class 2000 cleanliness

Nearly 2 km of rock sits above the lab, pressing on the surrounding rock and structure.

3 points

3 Identify two pieces of personal protective equipment and briefly explain why they are important during underground travel.

Answers may vary.

PPE #1: *Hard hat*

Explanation:

Hard hats are used underground to protect our heads from uneven rocks in the mine.

PPE #2: *Safety goggles*

Explanation:

Safety goggles are used to protect our eyes from chemicals and dust in the drift and in the lab.

4 points



SNOLAB POSTER ACTIVITY

MATERIALS

- Large paper or cardstock (11" x 17")
- Scrap or GOOS paper
- Pencils and erasers
- Colouring supplies
- Rulers
- Laptop (for accessing SNOLAB website)
- Projector
- Poster rubric and/or submission form

INSTRUCTIONS

1. As a class, spend some time looking at the SNOLAB website for inspiration. Focus especially on the Education section and any images, videos, or student resources to show what SNOLAB does
2. Briefly discuss what SNOLAB is and the type of science it supports (quantum science, particle science, etc.)
3. Explain the goal of the task. Students will create a poster to promote SNOLAB science to kids at other schools in Canada
4. Have students begin brainstorming ideas on blank/GOOS paper
5. When their rough draft is complete, students can begin working on their final copy
6. Students create their final poster using colour, images, and text
7. The poster must include:
 - a. A clear title promoting SNOLAB science
 - b. At least one visual representation of SNOLAB or underground science
 - c. A message or slogan
 - d. Something that represents science being done (dark matter, neutrinos, space, etc.)
8. Encourage students to use creativity to show things that cannot be seen
9. Display posters around the classroom and/or share them with E&O at SNOLAB!

DISCUSSION QUESTIONS

- Why do scientists choose to build a laboratory deep underground?
- What images or symbols did you choose to represent SNOLAB, and why?
- What is one thing you learned about SNOLAB from this activity?
- If you could improve your poster, what would you change or add?
- What science or experiment does your poster show? Why did you choose it?
- How did using art help you show science at SNOLAB?

CURRICULUM CONNECTIONS

- Language Arts: A1.2, A3.1, B1.1, B1.2, D1.2, D1.4, D2.1, D2.6, D3.1, D3.2
- Science & Technology: A1.1 - A1.5, A3.1, A3.2
- The Arts: D1.1, D1.3, D1.4, D2.2, D2.4



POSTER CHECKLIST

Name: _____

Poster Title: _____

- ☐ I completed a brainstorming draft.
- ☐ My poster has a clear title.
- ☐ I included a picture or drawing.
- ☐ I included a slogan or message.
- ☐ I showed a SNOLAB science topic.
- ☐ I used colour to make my poster stand out.
- ☐ My poster is neat and organized.
- ☐ I checked my work before handing it in.

Self-reflection

a) One thing I learned about SNOLAB is: _____

b) The best part of my poster is: _____

c) One thing I could do better next time is: _____



SNOLAB POSTER RUBRIC

Student name: _____

Poster title: _____

Criteria	Level 1: Beginning	Level 2: Approaching	Level 3: Proficient	Level 4: Exceeding
Understanding of SNOLAB science	Shows a limited understanding of SNOLAB science. Some information is missing and/or incorrect.	Shows some understanding of SNOLAB science. Most information is present and/or accurate.	Shows a good understanding of SNOLAB science. The information is accurate and/or relevant.	Shows a thorough understanding of SNOLAB science. The information is accurate, detailed, and insightful.
Communication of message or slogan	Message is missing and/or is difficult to understand.	Message is somewhat clear and understandable.	Message is clear and appropriate for the audience.	Message is highly effective and memorable for the audience.
Visual design and creativity	Uses none or few design elements to support the message.	Uses some design elements to support the message.	Uses design elements to effectively communicate the message.	Uses creative design elements to strongly communicate the message.
Required components	Includes few of the required components.	Includes some of the required components.	Includes most of the required components.	Includes all required components.
Planning and presentation	Work shows little to no planning and organization.	Work shows some planning and organization.	Work is well-planned, organized, and neat.	Work is very well-planned and highly organized.

Comments

SNOLAB POSTER SUBMISSION FORM

If you would like to send your poster to SNOLAB to get comments from us, fill out this form with the help of your teacher or parent/guardian. When complete, send your poster and this form via email to outreach@snolab.ca. The posters will be reviewed by SNOLAB staff and we will send back comments!

Student information

Name: _____

Age: _____ Grade: _____

School: _____

Teacher: _____

Contact email: _____

Poster information

Poster title: _____

Tell us a bit about your poster: _____



SIGNAL SEEKERS

MATERIALS

- Dice
- Calculators
- Writing utensils
- Signal seekers worksheet

INSTRUCTIONS

1. Divide students into groups of 3-4 students and distribute all materials
2. Explain that each roll of a die represents a particle event being detected by a scientific instrument
3. In their groups, students take turns rolling a die until they have completed a total of 50 rolls
4. Students record their results (from each roll) on the worksheet
5. A roll of the number 6 represents a "rare signal event" and all other numbers are "background noise". Students should tally their numbers for each.
6. After completing all 50 rolls, students create a graph to represent their results:
 - a. Grade 4-5: Create a bar graph showing the frequency of each number rolled
 - b. Grade 6-8: Create a line graph and calculate the percentage of signal events compared to background noise
7. Optional: As a class, combine the data from all groups to create a whole-class dataset
8. Analyse the class data and discuss whether the larger sample provides a clearer picture of the results
9. Discuss how this activity relates to the work conducted at SNOLAB. Emphasize that scientists often search through large amounts of background noise to identify rare signal events. Just as rolling a 6 was uncommon in this activity, neutrino interactions are extremely rare and can be difficult to detect. Scientists collect large amounts of data over long periods of time to increase the chances of finding these rare events
10. Have students write a brief conclusion describing what they learned about collecting data, identifying patterns, and detecting rare events

DISCUSSION QUESTIONS

- Which number appeared the most? The least?
- Did your results match what you expected? Why or why not?
- Why do you think different groups got different numbers of signal events? Do you think this happens in real-life experiments at SNOLAB?

CURRICULUM CONNECTIONS

- Language Arts: A1.2, A3.1, B1.1, B1.2
- Science & Technology: A1.1 - A1.5
- Mathematics: C4, D1.1, D1.2, D1.3, D1.6, D2.1,



SIGNAL SEEKERS

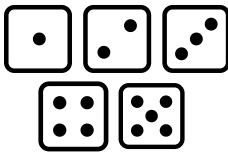
Name: _____

Background

At SNOLAB, scientists look for tiny particle interactions that are hidden among background signals. In this activity, each roll of a die represents a particle event. Your challenge is to collect data, analyze patterns, and search for rare signal events hidden within the background noise. As you work, you'll discover how data and probability help scientists make sense of the world around us.

Event key

Use the following key to help you complete the activity:



A roll of 1-5 represents
background noise



A roll of 6 represents a
rare particle signal

Predictions

a) How many signal events (6s) do you think your group will detect in 50 rolls?

b) Do you think every number will appear the same number of times? Explain.

Data tally

Keep a running tally of your results in the space below.



Results

Add up your tallies from the first page and put the results in the correct spot below.

Background noise (1-5s) _____

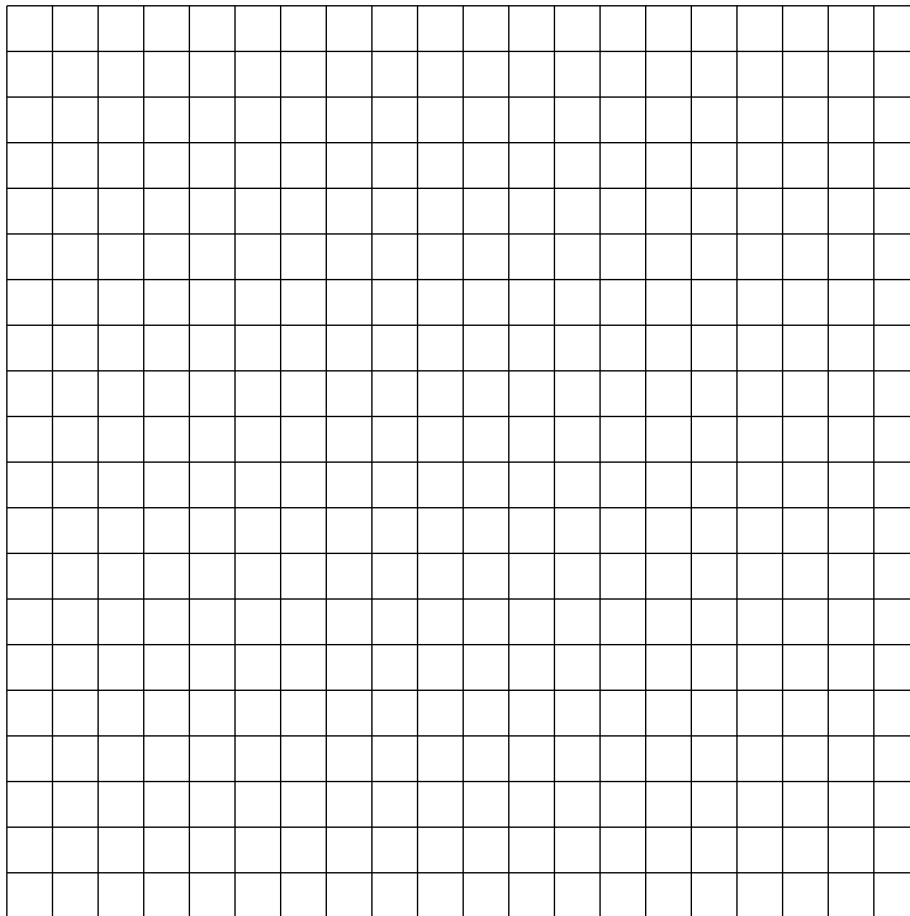
Rare particle events (6s) _____

Grades 6-8 ONLY: Calculate the percentage of each result above and put your answers on the lines below.

% Background noise (1-5s) _____

% Rare particle events (6s) _____

Graph your data



Analyse your data

- a) Which number appeared most often? _____
- b) Which number appeared least often? _____
- c) How many rare particle events did your group detect? _____
- d) Did your results match your predictions? Why or why not?

- e) Was it easy or difficult to find particle events among the background noise?

Conclusion

What did this activity teach you about data, probability, and the rare science at SNOLAB?

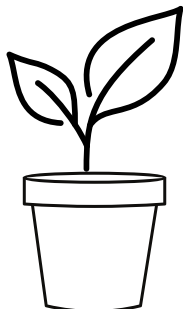


SESSION 4

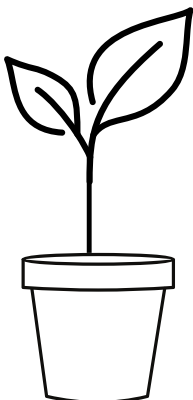
- SNOLAB & the scientific method Exit Ticket (Grade 4 - 6)
- SNOLAB & the scientific method Exit Ticket (Grade 7 - 8)
- SNOLAB & the scientific method Worksheet Answer Keys
- Extension Activity: SNOLAB charades (optional)
- Extension Activity: Under pressure (optional)



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:

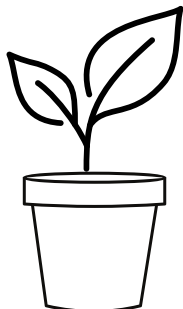
Independent variable:

Dependent variable:

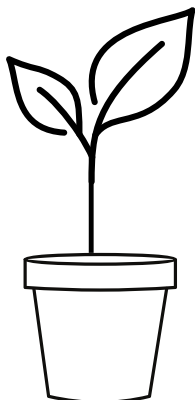
Control variable(s):

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

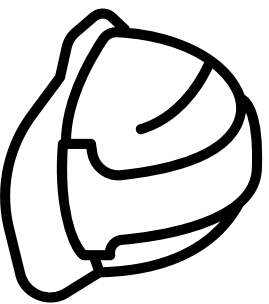
DISCUSSION QUESTIONS

- 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

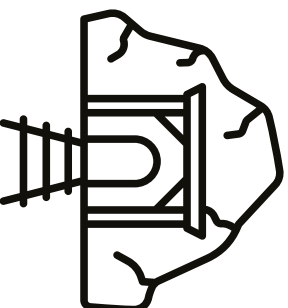
- Science & Technology: A3.1, A3.2
- The Arts: B1.1, B1.2

Putting on a hard hat



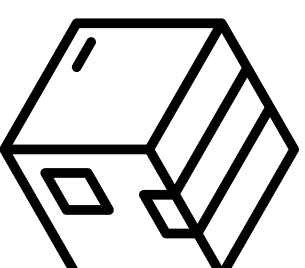
Fact: Everyone must wear lots of personal protective equipment (PPE) underground

Riding the cage underground



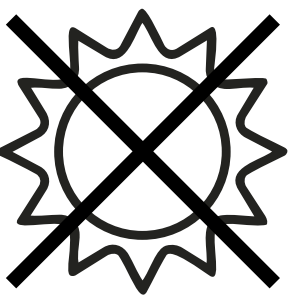
Fact: Scientists travel about 2 km underground to reach SNOLAB

Carrying an object carefully



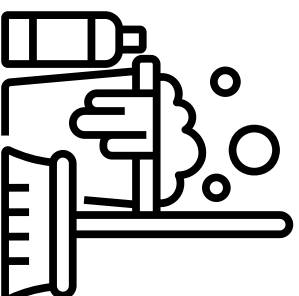
Fact: Sensitive equipment must be transported carefully underground

No sunlight underground



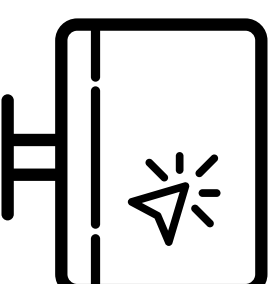
Fact: No natural sunlight reaches the lab underground, it is lit with artificial lights

Very clean lab space



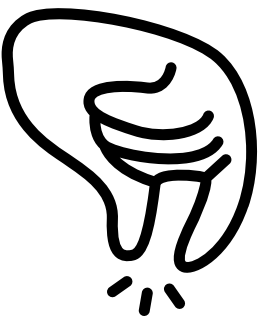
Fact: SNOLAB is a class 2000 clean lab, which prevents dust from dirtying experiments

Working on a computer



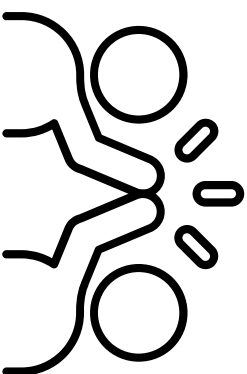
Fact: Scientists use computers to monitor experiments and record data underground.

Looking for
something tiny



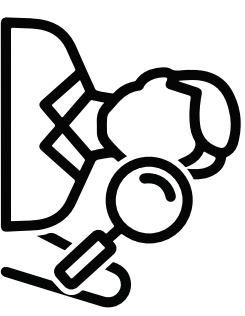
Fact: SNOLAB experiments look for very tiny particles that are hard to detect.

Scientists working
together



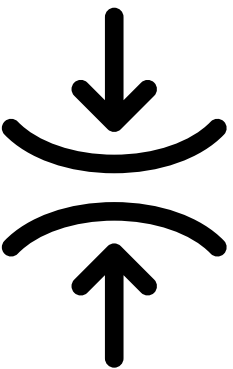
Fact: Scientists work together on experiments at SNOLAB to help make them better

Watching
experiments
carefully



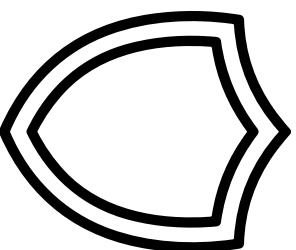
Fact: SNOLAB scientists carefully watch data to observe anything new or unusual

Higher pressure
underground



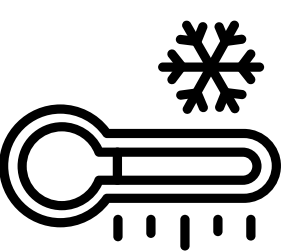
Fact: The 2 km of rock above the lab creates very high pressure compared to surface

Shield from space
particles



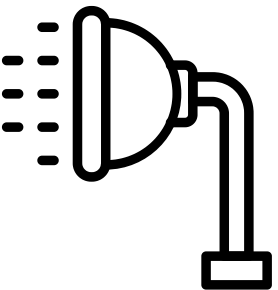
Fact: The rock above the lab acts like a shield that blocks many particles from space

Liquid nitrogen
cooling



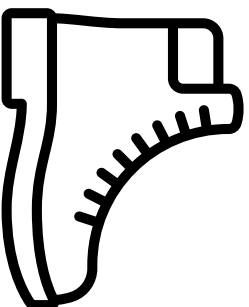
Fact: Some experiments use very cold temperatures and cryogenics to help get data.

Taking a shower underground



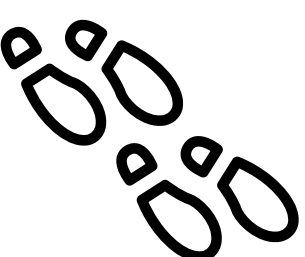
Fact: Scientists must take a shower underground before entering the clean lab area.

Using the boot wash station



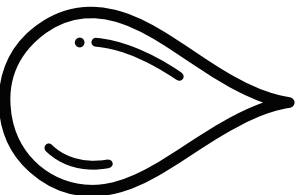
Fact: All boots must be washed before entering the clean lab area from the mine

Walking in the drift underground



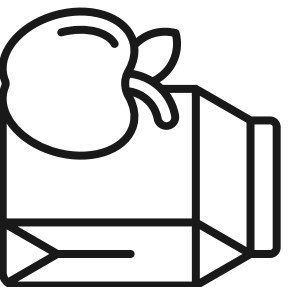
Fact: To get to the lab, scientists need to walk 1.4 km in a mine tunnel called a drift

Using ultra-pure water



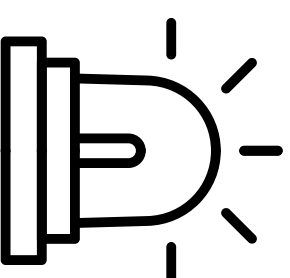
Fact: SNOLAB makes ultra-pure water that has no impurities and uses it for experiments

Eating lunch underground



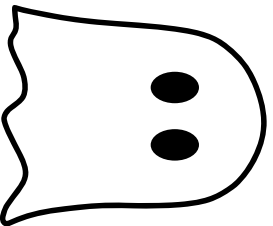
Fact: Workers and scientists take breaks and eat meals in designated areas underground

Emergency refuge station



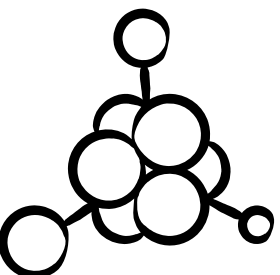
Fact: Refuge stations are safe underground areas that protect workers during emergencies

Finding ghost particles



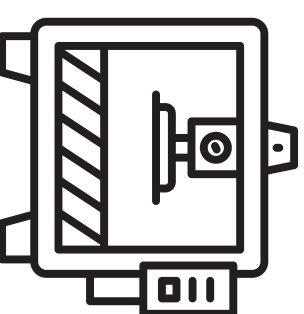
Fact: Scientists study “ghost particles” called neutrinos that pass through almost anything

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?



SESSION 5

- Experiment ideas brainstorming worksheet

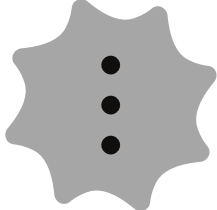




EXPERIMENT IDEAS BRAINSTORMING!

Name: _____

Grade: _____



Things I'm curious about

How I might test it

Questions I have

Drawings of my ideas



SESSION 6

- Science fact cards (Grade 4 - 6)
 - Science fact cards (Grade 7 - 8)
 - Final assessment (Grade 4 - 6) (optional)
 - Final assessment (Grade 7 - 8) (optional)
- 



The Earth spins to make day and night



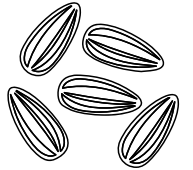
Bats use sound to find their way in the dark



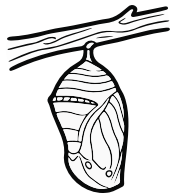
Bees help flowers by pollinating them



Plants grow from seeds



Caterpillars turn into butterflies



Plants grow toward sunlight



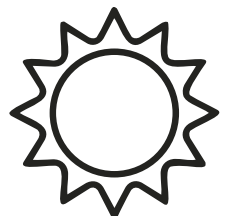
Sound travels in waves



Tornado winds can spin faster than race cars



The Northern Lights happen when particles from the Sun hit Earth's atmosphere

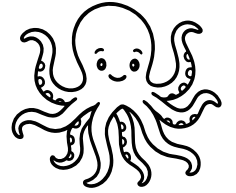




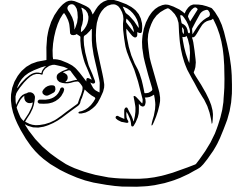
Rainbows are actually full circles – we usually only see parts of them



Octopuses have three hearts



Sloths can hold their breath longer than dolphins



Everyone has different fingerprints





The Northern Lights happen when cosmic rays hit Earth's atmosphere



Rainbows are actually full circles – we usually only see part of them



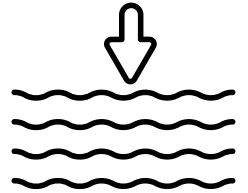
Photosynthesis turns sunlight into chemical energy for plants



Density determines whether something sinks or floats



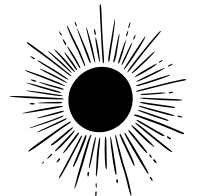
Ocean tides are caused mainly by the Moon's gravity



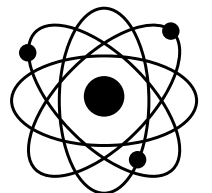
A black hole's gravity is so strong that not even light can escape it



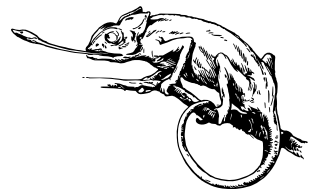
A solar eclipse happens when the Moon blocks the Sun



Atoms are made of protons, neutrons, and electrons

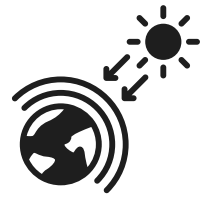


Camouflage helps animals blend into their environment

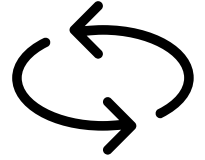




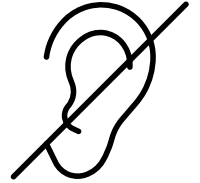
The ozone layer helps protect Earth from harmful UV rays



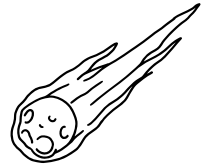
Day and night happen because Earth spins around the Sun



Sound cannot travel in outer space because there is no air



Shooting stars are really fast-moving space rocks





FINAL ASSESSMENT

Name: _____

1 Is this a **SMART** scientific question? Circle YES or NO.

Are jelly beans the best candy?	YES	NO
Does reading help you learn faster?	YES	NO
Does oil float on water?	YES	NO
Can I sing the best in my class?	YES	NO

2 Why shouldn't you change more than one variable at a time? Circle the best answer.

- a) It is hard to tell what caused the change
- b) It makes it easier to get good results
- c) The experiment will work better
- d) It doesn't matter how many you change

3 Order the steps of the scientific method from 1 to 5.

Share your results _____

Ask a question _____

Test the prediction _____

Make a prediction _____

Look at the results _____

4 Match the example with the variable type by drawing a line between them.

Time to melt the ice cube

Water temperature

Size of ice cube

Control variable
(what stays the same)

Independent variable (what we change)

Dependent variable (what is measured)

5

A student wants to see if a basketball bounces higher on surface or underground.

a) What question did they ask?

Do basketballs change colour underground?

Do basketballs bounce higher underground?

b) What prediction could they make?

c) The basketball underground did not bounce as high as the one on surface. Why did this happen?

There is more pressure underground

There is less pressure underground

6

**What is one thing you learned about SNOLAB during the program?
Draw a picture and write a short sentence.**



FINAL ASSESSMENT

Name: _____

1 Why is this question a SMART scientific question? Explain.

Does a basketball bounce higher underground or on surface?

2 When designing an experiment, why is it important to only change one variable at a time? What would happen if you tried to change too many at once?

3 Order the steps of the scientific method from 1 to 5 on the lines below.

Share your results	_____
Ask a question	_____
Test the prediction	_____
Make a prediction	_____
Look at the results	_____

4 Match the variable to the example by drawing a line.

Time for sugar to dissolve	Control variable(s)
Amount of sugar and water	Dependent variable
Water temperature	Independent variable

5

A student wants to investigate whether being on a phone before going to sleep affects sleep quality. Write out the following information for the experiment:

a) The SMART scientific question: _____

b) A prediction: _____

c) The results they might see and why: _____

6

Calculate the mean, median, mode and range for the results of a SNOLAB experiment shown below.

Test #	Speed (m/s)
1	13.25
2	12.96
3	13.72
4	14.01

7

Name a fact about SNOLAB that you learned during the program.



FINAL ASSESSMENT

Name: TOTAL: 18 points

1

Is this a **SMART** scientific question? Circle YES or NO.

4 points

Are jelly beans the best candy?

YES

NO

Does reading help you learn faster?

YES

NO

Does oil float on water?

YES

NO

Can I sing the best in my class?

YES

NO

2

Why shouldn't you change more than one variable at a time? Circle the best answer.

a) It is hard to tell what caused the change

b) It makes it easier to get good results

c) The experiment will work better

d) It doesn't matter how many you change

1 point

3

Order the steps of the scientific method from 1 to 5.

Share your results

5

Ask a question

1

Test the prediction

3

Make a prediction

2

Look at the results

4

5 points

4

Match the example with the variable type by drawing a line between them.

3 points

Time to melt the ice cube

Control variable
(what stays the same)

Water temperature

Independent variable (what we change)

Size of ice cube

Dependent variable (what is measured)

5

A student wants to see if a basketball bounces higher on surface or underground.

3 points (1 each)

a) What question did they ask?

Do basketballs change colour underground?

Do basketballs bounce higher underground?

b) What prediction could they make?

Answers may vary. EXAMPLE: I think that basketballs underground will bounce less than on surface.

c) The basketball underground did not bounce as high as the one on surface. Why did this happen?

There is more pressure underground

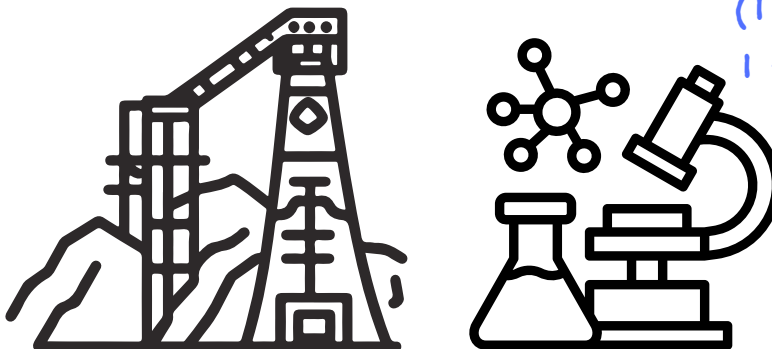
There is less pressure underground

6

What is one thing you learned about SNOLAB during the program?
Draw a picture and write a short sentence.

2 points

(1 for drawing,
1 for sentence)



Answers may vary. EXAMPLE: I learned that, at

SNOLAB, they do science in a mine underground.



FINAL ASSESSMENT

Name: TOTAL: 27 points

3 points

1 Why is this question a SMART scientific question? Explain.

Does a basketball bounce higher underground or on surface?

This is a SMART scientific question because it is
specific, measurable, attainable, relevant, and timely.
Therefore, the question can easily be tested and the
results obtained can provide us with new knowledge.

2

When designing an experiment, why is it important to only change one variable at a time? What would happen if you tried to change too many at once?

3 points

When designing an experiment, it is important to only change
one variable at a time because it allows the changes to be
better observed. If too many things are changed at once, it
gets harder to tell which variable is causing the change and the
results will be unclear.

3

5 points

Order the steps of the scientific method from 1 to 5 on the lines below.

Share your results	5
Ask a question	1
Test the prediction	3
Make a prediction	2
Look at the results	4

4

3 points

Match the variable to the example by drawing a line.

Time for sugar to dissolve	Control variable(s)
Amount of sugar and water	Dependent variable
Water temperature	Independent variable

5

A student wants to investigate whether being on a phone before going to sleep affects sleep quality. Write out the following information for the experiment: **4 points (2 for part C)**

a) The SMART scientific question: **Answers may vary. EXAMPLE:**

Does phone use before bed affect your sleep at night?

b) A prediction: **Answers may vary. EXAMPLE: I think that**

being on your phone before bed will make you sleep worse

c) The results they might see and why: **Answers may vary. EXAMPLE:**

Being on your phone makes you sleep worse because of the blue light.

6

Calculate the mean, median, mode and range for the results of a SNOLAB experiment shown below. **8 points (2 each)**

Test #	Speed (m/s)
1	13.25
2	12.96
3	13.72
4	14.01

Mean: $13.25 + 12.96 + 13.72 + 14.01 = 53.94 / 4 = 13.485$

Median: $13.25 + 13.96 = 27.21 / 2 = 13.605$

Mode: There is no mode for this data set.

Range: $14.01 - 12.96 = 1.05$

7

Name a fact about SNOLAB that you learned during the program. **1 point**

Answers may vary. EXAMPLE: I learned that SNOLAB is a science lab that is 2 km underground at Creighton Mine in Sudbury.