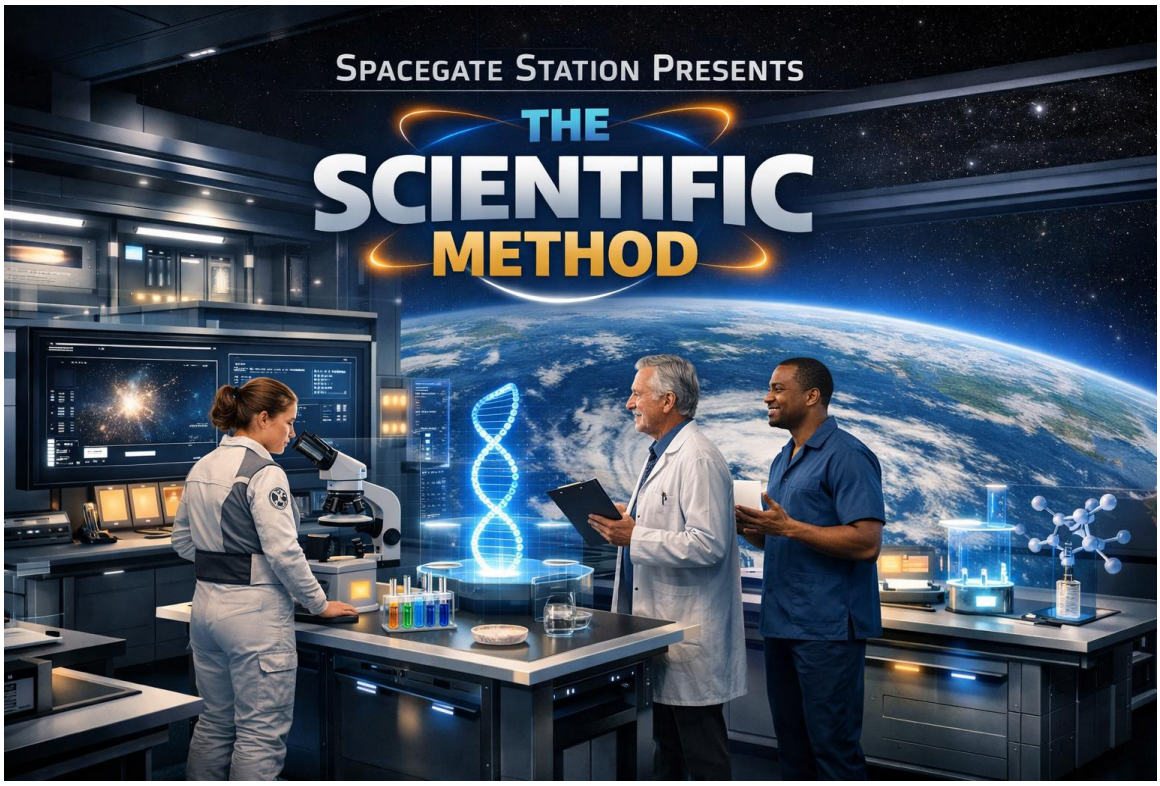
Spacegate Station

Scientific Method



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Curriculum Alignment Page

Grade Band: Middle School (6–8)
Focus Areas: Scientific Method, Experimental Design, Variables, Hypothesis Testing
Episode Length: 11 minutes
Learning Objectives

After viewing this episode, students will be able to:

- Describe the steps of the scientific method.
- Differentiate between independent, dependent, and confounding variables.
- Explain the importance of forming a testable and falsifiable hypothesis.
- Understand how to design and conduct an experiment.
- Analyze data and draw conclusions based on evidence.
- Recognize the importance of clear communication in science.

Lesson Procedure

1. Engage (10 minutes) SC.6.N.1.1, MS-ETS1-1

- Show opening clip introducing the scientific method (00:00:08–00:03:48)
- Distribute Guided Notes – Section 1
    - Ask: *What is science and how do scientists answer questions?*
- Teacher Focus:
    - Activate prior knowledge
    - Introduce scientific method as a structured process

2. Explore (15 minutes) SC.6.N.1.2, SC.6.N.1.3

- Video Segment: Research Questions & Hypotheses (00:03:48–00:07:35)
- Students complete Guided Notes – Section 2
- Small Group Task:
    - Write a sample research question ("How does X affect Y?")
    - Develop a hypothesis using *If…then…because*

3. Explain (15 minutes) SC.6.N.1.4

- Video Segment: Variables (0:07:35 – 00:09:40)
- Guided Notes – Section 3
- Class Discussion:
    - What is the difference between independent and dependent variables?
    - Why are confounding variables important?

4. Elaborate (20 minutes) MS-ETS1-3, SC.7.N.1.2

Part A: Scientific Method Lab (10–15 min)

Activity: Ice Melting Investigation

- Students compare melting rate of whole vs. crushed ice
- Identify:
  - Independent variable → surface area
  - Dependent variable → melting time
- Collect and record data

Part B: Discussion & Analysis (5–10 min)

- How did variables affect results?
- Was the hypothesis supported?
- How could the experiment be improved?

5. Evaluate (10 minutes) SC.7.N.1.2

Video Segment**:** 00:09:40 – 00:10:22 (Communication of Results)

Student Tasks:

1. What is the first step of the scientific method?
2. What is a hypothesis?
3. Identify independent vs. dependent variable in an example
4. Reflection:
   - *Why is it important to control variables in an experiment?*

Assessment

- Guided Notes completion
- Lab data table & analysis
- Exit ticket responses
- Participation in discussions

Differentiation

- Support:
  - Provide sentence stems for hypotheses
  - Use visuals for variables
- Extension:
  - Students design their own experiment
  - Introduce null hypothesis and data graphs

Name: _____ Period: _____ Date: _____

Scientific Method Guided Notes

analysis	experiment	null hypothesis
conclusion	falsifiable	observation
confounding variable	hypothesis	research question
control	independent variable	scientific method
dependent variable	literature	testable

SECTION 1 — Introduction to the Scientific Method (00:00:08 – 00:03:48)

The _____ is a systematic approach used to explore observations and test hypotheses.

The first step in the scientific method is making an _____.

Scientists often review existing _____ to understand what is already known.

SECTION 2 — Research Questions & Hypotheses (00:03:48 – 00:07:35)

A _____ helps guide the direction of an experiment and is often phrased as "How does X affect Y?"

A _____ is an educated guess based on prior research and observations.

A good hypothesis must be _____ and _____.

The _____ is a statement that there is no effect or relationship between variables.

SECTION 3 — Variables in an Experiment (00:04:18 – 00:06:23)

The _____ variable is the one that is changed or controlled in a scientific experiment.

The _____ variable is the one being tested and measured.

A _____ variable is not included in the experiment but can affect the results.

A well-designed experiment includes _____ to eliminate the influence of external variables.

SECTION 4 — Designing & Conducting Experiments (00:07:35 – 00:09:40)

During the _____ phase, the experiment is carried out and data is collected.

After data is collected, scientists perform _____ to interpret the results.

The final step is drawing a _____ and sharing the results with others.

Guided Notes Answer Key

SECTION 1 — Introduction to the Scientific Method

1. scientific method

2. observation

3. hypothesis

SECTION 2 — Research Questions & Hypotheses

4. research question

5. independent variable

6. dependent variable

7. confounding variable

SECTION 3 — Variables in an Experiment

8. research question

9. testable, falsifiable

10. null hypothesis

11. experiment

SECTION 4 — Designing & Conducting Experiments

12. analysis

13. conclusion

14. literature

15. control

Unit Glossary

Analysis: Examining data to identify trends, patterns, or relationships.

Cause and Effect: A relationship where one action produces a result.

Communication (Scientific Communication): Sharing results through writing, speaking, or visual representations.

Conclusion: A summary of the results explaining whether the hypothesis was supported or rejected.

Confounding Variable: An outside factor that may unintentionally affect the results.

Control (Controlled Variables): Conditions that are kept the same in an experiment to ensure fair testing.

Control Group: The group that does not receive experimental treatment; used for comparison.

Data: Information collected during an experiment.

Data Table: Organized chart used to record experimental results.

Dependent Variable: The factor that is measured or observed; it responds to the independent variable.

Ethics in Science: Honesty and integrity in conducting and reporting research.

Evidence: Data used to support a claim or conclusion.

Experiment: A controlled procedure used to test a hypothesis.

Falsifiable: Able to be proven wrong through evidence.

Graph: A visual representation of data used to identify patterns.

Hypothesis: An educated, testable explanation based on observations and prior knowledge.

Independent Variable: The factor that is changed or manipulated by the scientist.

Model: A simplified representation used to explain or predict a scientific concept.

Null Hypothesis: A statement that predicts no relationship or no effect between variables.

Observation: Careful noting and recording of information using senses or tools.

Procedure: Step-by-step instructions used to carry out an experiment.

Qualitative Data: Descriptive data (color, shape, texture).

Quantitative Data: Numerical measurements (time, mass, temperature).

Replication: Repeating an experiment to verify results.

Research (Literature Review): Gathering background information from reliable sources before conducting an experiment.

Research Question: A clear, testable question that guides an investigation (often written as "How does X affect Y?").

Scientific Explanation: A claim supported by evidence and reasoning.

Scientific Method: A systematic process used by scientists to ask questions, test ideas, analyze data, and draw conclusions.

System: A group of interacting components working together.

Testable: Able to be tested through an experiment.

Trials: Repeated tests to improve accuracy and reliability.

Higher-Order Discussion Sheet

1. Systems Thinking — Why is it important to follow a structured process like the scientific method when conducting experiments? (00:09:36 – 00:10:04)

2. Human Impact — How can understanding variables help scientists design better experiments? (00:04:18 – 00:05:30)

3. Cause and Effect — Why is it important to identify confounding variables in an experiment? (00:05:41 – 00:06:18)

4. Cross-Cultural Understanding — Why is it important for scientists around the world to use consistent methods and terminology? (00:10:04 – 00:10:22)

5. Data Interpretation — How does analyzing data help scientists draw accurate conclusions? (00:09:01 – 00:09:29)

6. Ethical Decision-Making — What responsibilities do scientists have when reporting their findings? (00:09:29 – 00:09:40)

7. Engineering and Technology — How might technology help improve the accuracy of experiments in space? (00:00:58 – 00:02:14)

8. Language and Science — Why is it important to use clear and precise language in scientific communication? (00:10:04 – 00:10:22)

9. Real-World Application — How can the scientific method be applied to solve everyday problems? (00:09:49 – 00:10:03)

10. Reflection — What part of the scientific method do you find most challenging, and why? (00:07:03 – 00:07:35)

Higher-Order Discussion Sheet Sample Responses

1. Systems Thinking — Why is it important to follow a structured process like the scientific method when conducting experiments? (MS-ETS1-1, C.6.N.1.1, SC.6.N.1.2)

> **Sample Response**: Following a structured process ensures that experiments are organized, repeatable, and based on evidence rather than guesswork. It helps scientists avoid errors and allows others to verify the results.

2. Human Impact — How can understanding variables help scientists design better experiments? (SC.6.N.1.4, MS-ETS1-4)

> **Sample Response**: Understanding variables helps scientists control what changes and what stays the same. This makes experiments more accurate and ensures that results are caused by the factor being tested, not by outside influences.

3. Cause and Effect — Why is it important to identify confounding variables? (SC.6.N.1.4, MS-ETS1-3)

> **Sample Response**: Confounding variables can change the results without the scientist realizing it. Identifying them helps ensure that the experiment measures the true relationship between independent and dependent variables.

4. Cross-Cultural Understanding — Why is consistent scientific language important worldwide? (MS-LS1-5, SC.6.N.1.2)

> **Sample Response**: Using consistent methods and terminology allows scientists from different countries to understand each other's work, repeat experiments, and build on shared knowledge.

5. Data Interpretation — How does analyzing data help scientists draw accurate conclusions? (MS-ETS1-3, SC.7.N.1.2)

> **Sample Response**: Data analysis helps scientists look for patterns, compare results, and determine whether their hypothesis was supported. Without analysis, conclusions would be based on opinion instead of evidence.

6. Ethical Decision-Making — What responsibilities do scientists have when reporting findings? (MS-LS1-3, C.6.N.1.1)

> **Sample Response**: Scientists must report results honestly, avoid changing data, and share enough information for others to repeat the experiment. Ethical reporting builds trust and protects the integrity of science.

7. Engineering & Technology — How might technology improve experiment accuracy in space? (MS-ETS1-4, SC.7.N.1.1)

> **Sample Response**: Technology such as sensors, automated data collection tools, and computer models can reduce human error and allow experiments to run in environments where people cannot safely work.

8. Language and Science — Why is precise language important in scientific communication? (MS-LS1-5, SC.6.N.1.3)

> **Sample Response**: Precise language prevents misunderstandings and ensures that procedures, data, and conclusions are clear. This helps other scientists repeat the experiment correctly.

9. Real-World Application — How can the scientific method help solve everyday problems? (C.6.N.1.1, MS-ETS1-2)

> **Sample Response**: People can use the scientific method to test solutions, compare results, and make decisions based on evidence, such as improving a study routine, fixing a device, or choosing the best method for a task.

10. Reflection — What part of the scientific method is most challenging, and why? (MS-ETS1-3, SC.7.N.1.2)

> **Sample Response**: Students may find forming a testable hypothesis challenging because it requires clear thinking and understanding of the problem. Others may struggle with analyzing data because it involves interpreting evidence.

Scientific Method – Exit Ticket

Name: _____ Period: _____ Date: _____

Part 1: Multiple Choice

1. What is the first step of the scientific method?
☐ A. Form a conclusion
☐ B. Make an observation
☐ C. Conduct an experiment
☐ D. Analyze data

2. Which variable is changed by the scientist?
☐ A. Dependent variable
☐ B. Independent variable
☐ C. Control variable
☐ D. Confounding variable

3. What must a good hypothesis be?
☐ A. Opinion-based and creative
☐ B. Testable and falsifiable
☐ C. Long and detailed
☐ D. Based only on guesses

Part 2: Short Response

4. Explain the difference between independent and dependent variables.

5. Why is it important to control variables in an experiment?

6. How can the scientific method be used to solve a real-world problem?

Exit Ticket Answer Key

Part 1: Multiple Choice

1. Correct Answer: B — Make an observation
Explanation: The scientific method begins with observing a phenomenon or asking a question.

2. Correct Answer: B — Independent variable
Explanation: The independent variable is the factor that the scientist changes during an experiment.

3. Correct Answer: B — Testable and falsifiable
Explanation: A valid hypothesis must be able to be tested and potentially proven wrong.

Part 2: Short Response

4. Expected Answer:

- The independent variable is the factor that is changed by the scientist.
- The dependent variable is the factor being measured or observed as a result.

Acceptable Elements:

- "changed vs. measured"
- "cause vs. effect"

5. Expected Answer:

- Controlling variables ensures a fair test.
- It helps make sure results are caused by the independent variable and not outside factors.

Acceptable Elements:

- Eliminates confounding variables
- Improves accuracy and reliability

6. Sample Answer:

- The scientific method can be used to test solutions to everyday problems, such as finding the best way to study, growing plants faster, or fix a device. It helps people make decisions based on evidence rather than guesswork.

How Does Surface Area Affect Ice Melting Rate?

Overview: This quick, high-engagement lab allows students to apply the scientific method in a single class period (35–50 minutes). Students compare how fast a whole ice cube melts versus crushed ice of the same volume. The lab reinforces key concepts from the episode and guided notes: independent/dependent variables, confounding variables, hypothesis formation, data collection, analysis, and conclusion writing.

The activity is simple, requires minimal materials, and produces measurable results within minutes.

- Instructional Purpose - This lab is designed to help students:
- Practice forming testable and falsifiable hypotheses
- Identify independent, dependent, and confounding variables
- Collect and analyze quantitative data
- Apply the scientific method in a controlled investigation
- Draw evidence-based conclusions

The lab directly supports the learning objectives and standards listed in the Spacegate Station Episode 27 curriculum alignment.

- Time Required: 35–50 minutes
- Introduction & setup: 5–7 minutes
- Experiment run time: 10–15 minutes
- Data analysis: 10 minutes
- Conclusion writing & discussion: 10–15 minutes

Materials (per group of 3–4 students)

- 1 whole ice cube
- 1 small cup of crushed ice (same approximate volume as the cube)
- 2 identical cups
- Timer/stopwatch (phones or projected classroom timer work fine)
- Paper towels
- Student lab sheet
- Optional: digital scale for more precise measurement

Teacher Setup Notes

- Pre-portion crushed ice into small cups to save time.
- Ensure all groups receive equal amounts of ice to reduce confounding variables.
- If crushed ice is not available, students can break ice cubes using a sealed bag and a mallet.
- Keep airflow consistent (avoid placing groups near vents).

Safety Considerations

- Ice may cause slippery surfaces; keep paper towels available.
- Students should avoid handling ice for long periods to prevent discomfort.
- No chemicals or heat sources are used, making this lab safe for all classrooms.

Expected Student Outcomes

Students should observe that:

- Crushed ice melts faster than a whole ice cube.
- Increased surface area speeds up heat transfer.
- Controlled variables help ensure fair testing.

Note: Confounding variables (unequal ice amounts, warm hands, airflow) can affect results.

Students will produce:

- A testable hypothesis
- A completed data table
- Analysis responses
- A written conclusion supported by evidence

Scientific Explanation (Teacher Background):

Crushed ice has more surface area exposed to warm air and the cup surface. This increases the rate of heat transfer, causing it to melt faster. This concept connects to real-world applications such as weathering, dissolving, and thermal energy transfer.

Debrief Questions (Optional)

- Why is it important to control variables in this experiment?
- How could you redesign this experiment to improve accuracy?
- What real-world situations involve surface area affecting melting or dissolving?

Standards Alignment

NGSS (Middle School)

- MS-ETS1-1: Students define the problem and identify variables.
- MS-ETS1-3: Students collect and analyze data to determine patterns.
- MS-ETS1-4: Students test a model system and refine understanding.
- MS-LS1-5: Students use evidence to support explanations.

Florida B.E.S.T. Science Standards

- C.6.N.1.1: Students plan and carry out a scientific investigation.
- SC.6.N.1.2: Students understand why investigations must be replicable.
- SC.6.N.1.3: Students distinguish experiments from other types of investigations.
- SC.6.N.1.4: Students identify independent, dependent, and confounding variables.
- SC.7.N.1.2: Students analyze data and use evidence to form conclusions.

Name: _____ Period: _____ Date: _____

"How Does Surface Area Affect Ice Melting Rate?"
A Scientific Method Investigation

STUDENT LAB SHEET

Title: How Does Surface Area Affect the Melting Rate of Ice?

Purpose: To investigate how changing the surface area of ice affects how quickly it melts.

Background: The scientific method helps scientists test hypotheses. In this lab, you will identify variables, collect data, and analyze results in one class period.

Research Question: How does the surface area of ice affect the time it takes to melt?

Hypothesis:
Write a hypothesis using: an If… then… because…

Variables

- Independent Variable: Surface area of the ice (whole cube vs. crushed ice)
- Dependent Variable: Time it takes to melt (minutes/seconds)
- Controls: Same amount of ice, same container, same room temperature

Materials (per group)

- 1 ice cube
- 1 small cup of crushed ice (same volume as cube)
- 2 identical cups
- Timer or stopwatch
- Paper towels

Procedure

1. Place one whole ice cube into Cup A.
2. Place an equal amount of crushed ice into Cup B.
3. Start the timer.
4. Observe both cups every 30 seconds.
5. Record the time when each sample is completely melted.
6. Compare the melting times.

Data Table

Ice Type	Start Time	End Time	Total Time to Melt	NOTES
Whole Ice Cube				
Crushed Ice				

Analysis Questions
Which melted faster?

Why do you think that happened?

What confounding variables might have affected your results?

Was your hypothesis supported or rejected?

Conclusion
Write 3–4 sentences explaining what you learned about surface area and melting rate.

TEACHER Lab ANSWER KEY

Sample Hypothesis

If ice has more surface area, then it will melt faster because more of it is exposed to the warm air.

Expected Results

- Crushed ice melts significantly faster than a whole cube.
- Students will see a clear difference within minutes.

Analysis Answers

- Crushed ice melts faster.
- It has greater surface area, allowing heat to transfer more quickly.

Possible confounding variables:

- Students touching ice
- Unequal ice amounts
- Airflow from fans/AC
- Differences in cup thickness

Hypothesis

Most students will find their hypothesis supported.

Conclusion (Sample)

The crushed ice melted faster than the whole ice cube. This happened because crushed ice has more surface area exposed to warm air. The increased surface area allows heat to enter the ice more quickly. Therefore, surface area affects melting rate.

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Florida B.E.S.T. Science Standards Alignment

C.6.N.1.1 — Define a problem, plan and carry out scientific investigations.
Episode Connection: The scientific method step-by-step. Observation, research question Hypothesis, experiment design, and data collection

SC.6.N.1.2 — Explain why scientific investigations should be replicable.
Episode Connection: Emphasizes testable, measurable, and falsifiable hypotheses which are all essential for replication. Testable hypotheses, controlled variables, repeatable procedures.

SC.6.N.1.3 — Distinguish between experiments and other types of scientific investigation.
Episode Connection: Discussion about controlled experiments, references literature review and observation. Observational, experimental, and background research

SC.6.N.1.4 — Identify variables in an experiment.
Episode Connection: Detailed explanations of independent, dependent, and confounding variables. Independent variable, dependent variable, confounding variables, and controls.

SC.7.N.1.1 — Define a problem, use reference materials, plan and carry out investigations.
Episode Connection: Students see how scientists use prior research to form hypotheses and design experiments. Literature review, research question formation, and experimental planning

SC.7.N.1.2 — Differentiate between qualitative and quantitative data.
Episode Connection: How scientists collect and analyze data. Data collection, data analysis, and evidence-based conclusions

NGSS Alignment (Middle School)

MS-ETS1-1 — Define the criteria and constraints of a design problem.
Episode Connection: Identifying the purpose of the experiment, recognizing environmental limitations, understanding why the experiment is needed.

MS-ETS1-2 — Evaluate competing design solutions using a systematic process.
Episode Connection: How scientists review existing literature and evaluate what has already been tested. Reviewing background research, comparing what is known vs. unknown, and identifying gaps in scientific understanding.

MS-ETS1-3 — Analyze data from tests to determine similarities and differences.
Episode Connection: How scientists collect and analyze data to confirm or reject hypotheses. Data collection, data interpretation and using evidence to draw conclusions.

MS-ETS1-4 — Develop a model to generate data for iterative testing.
Episode Connection: Designing experiments, identifying variables and iterative testing and refinement

MS-LS1-3 — Use argument supported by evidence for how the body maintains internal conditions.
Episode Connection: (Indirect connection — scientific method foundation) Students learn how evidence is used to support or refute hypotheses. Evidence-based reasoning, rejecting or confirming hypotheses.

MS-LS1-5 — Construct a scientific explanation based on evidence.
Episode Connection: How scientists draw conclusions and communicate results. Forming conclusions, communicating findings, and using evidence to support explanations

Science & Engineering Practices (SEPs) Asking Questions & Defining Problems

- Developing & Using Models
- Planning & Carrying Out Investigations
- Analyzing & Interpreting Data
- Using Mathematics & Computational Thinking
- Constructing Explanations & Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, & Communicating Information