

THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Reversible Changes

When things are changed by heat or cold, can they be changed back?

GRADE 2

Physical Science





Reversible Changes

Grade Level/Content	2/Physical Science
Lesson Summary	In this lesson, students apply heating and/or cooling to create changes in objects, and then discover which of those changes are reversible and which are not.
Estimated Time	3, 45-minute class periods
Materials	Objects that change as a result of heating and/or cooling: water, ice, butter, chocolate, egg, plant leaf, cookie dough, apple, soup, bread, popping corn, etc.; heating device (hot plate, microwave, stove top, or oven); cooling device (refrigerator, freezer, bowl of ice); Investigation Plan ; Observation Form ; journal
Secondary Resources	<ul style="list-style-type: none">• Song clip: “Changes” in the movie <i>Shrek 2</i> (1:19)• <i>The Secrets of Heat and Cold</i> by Andrew Solway
NGSS Connection	2-PS1-4 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
Learning Objectives	<ul style="list-style-type: none">• Students describe the characteristics of a material before heating/cooling is applied, after heating/cooling is applied, and after heating/cooling is reversed.• Students use evidence to determine and describe which changes to an object made by heating or cooling can be reversed and which cannot.
Cross-Curricular Project Connections	Wonderful Water, Superhero by Design

When things are changed by heat or cold, can they be changed back?

All matter is affected by heating and cooling. Some material is affected only microscopically, while other materials have dramatic changes even with small changes in temperature. It’s important for students to understand how heating and cooling affects different kinds of materials. It is also important for them to understand that some of these changes are reversible and some are not. In this lesson, students think and act like scientists as they discover for themselves which changes can be reversed and which cannot.

Understanding that some changes in matter are reversible and some are not gives students a foundational understanding of matter that they will need in later grades when they study: how mixing substances results in new substances (Grade 5: NGSS 5-PS1-4); the molecular-level changes of solids, liquids, and gases as a result of adding or removing thermal energy (Middle School: NGSS MS-PS1-4); and eventually, how as the kinetic energy of colliding particles increases and the number of collisions increases, reaction rate increases (High School: NGSS HS-PS1-5).

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science.
In all investigations:



Students don’t know the “answer” they are supposed to get.



Students play a driving role in determining the process for learning.



Teachers and students construct meaning together by journaling.



Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Students will need the following:

- Objects that change as a result of heating and/or cooling (water, ice, butter, chocolate, egg, plant leaf, cookie dough, apple, soup, bread, popping corn, etc.)
- Heating device (hot plate, microwave, stove top, or oven)
- Cooling device (refrigerator, freezer, bowl of ice)
- [Investigation Plan](#)
- [Observation Form](#)
- Journal

Since this investigation requires time for things to heat and cool, you may want to conduct the initial heating and/or cooling during one class period, try to reverse the change during a second class period, then analyze the data and construct an explanation in a third class period.

Part 2

INVESTIGATION FACILITATION



Question

Introduce the investigation question.

When things are changed by heat or cold, can they be changed back?

CREATIVE THINKING

Songs can be an engaging way to kick off a lesson. Begin this lesson by playing a clip from the song, “Changes” in the movie *Shrek 2*. Discuss how in the movie, Shrek changes from an ogre to a handsome prince and then back to an ogre. Explain that students will investigate changes to different materials and whether those changes are reversible or not. (If students like the song, you may have them rewrite the lyrics to the chorus based on their investigation results at the end of the lesson.)



Personal Knowledge

Students capture what they already know about how heating and cooling changes certain materials.

- Ask students to think of things that are changed when you apply heat (*butter, chocolate, ice, egg, cookie dough*).
- Ask students to think of things that are changed when you apply cooling (*water, plant leaf, fruit, soup, piece of bread*).
- Ask if any of these changes can be reversed.



Observation

Demonstrate how heating and/or cooling changes an object and whether or not that change is reversible.

- Choose one material to demonstrate the effect of heating or cooling for the class, for example popping corn.
- Start by describing the characteristics of the kernels (*dark yellow, triangle-shaped, hard, less than 1 centimeter long*).
- Have the class watch as you heat up the kernels and as they turn into popcorn.
- Describe the characteristics of the popcorn (*white or light yellow, cloud-shaped, soft, about 2 centimeters long*).
- Then, put the popcorn over a bowl of ice and ask students if they think that by applying cooling the popcorn will go back to being kernels.
- When students see that the popcorn does not reverse back into kernels, ask students to think about whether this might be true for all materials or just some materials.

CURIOSITY AND CREATIVITY

Ask students if they have ever thought about whether an object changed by heating or cooling can be changed back. Explain that scientists have to be curious and creative to ask questions that other people might not have thought about before.



Investigation Plan

Students investigate whether the changes applied to an object by heating or cooling can be reversed or not.

- Divide the class into teams of 3 or 4. Have each team choose an object from the table below (or another of your choice) to investigate:

Things you can HEAT (saute, boil, bake, or melt)	Things you can COOL (freeze)
Ice	Water
Butter	Butter
Chocolate	Plant leaf
Egg	Apple
Soup	Soup
Cookie dough	Bread

- Give teams the [Investigation Plan](#) and review it as a class. Explain that each group will need to decide how to heat or cool their item and how to try and reverse the changes.
- Guide students as needed in constructing their plans. You will likely need to give them some suggestions on how to heat/cool their objects. Have them get your approval on the final plan before they begin their investigation.
- Then, ask students to conduct their investigation according to their plans. They may want to take photos or draw pictures in addition to their descriptions.

INVESTIGATION PLAN
REVERSIBLE CHANGES

Object we are investigating: _____

We are applying (circle one): heat cold

1. Observe your object. Describe its characteristics. Record your observations in the "Before" section of the **Observation Form**.
2. Apply heating/cooling by _____
3. Observe your object again. Describe its characteristics. Record your observations in the "After" section of the **Observation Form**.
4. Try to reverse the change by _____
5. Observe your object again. Describe its characteristics. Record your observations in the "Reverse" section of the **Observation Form**.

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Investigation Plan

SHARED CONTROL

Having students construct part of the investigation plan gives them ownership in their learning process. They learn that figuring out how to answer a question is sometimes more important than the answer itself.

Continued

ADAPTABILITY

Students may encounter difficulty with their investigation plan. If their initial plan doesn't seem to be working, let them edit their plan and try another way. Teach students to value the exploration of multiple ways to accomplish a task. Sometimes students get stuck on plan A and are unable to move quickly to the exploration of plan B.



Observation

Students record their observations about the characteristics of their objects.

- Students should discuss the characteristics of their object before they apply heating/cooling, after they apply heating/cooling, and after they try to reverse the change.
- All observations should be recorded on the [Observation Form](#).
- They should record both quantitative characteristics (measurements) and qualitative (descriptions) as data.

COLLABORATION

Encourage students to define roles for themselves during the investigation. Some sample roles might be *Microwave Operator*, *Timer*, *Recorder*, *Stirrer*, etc. When students have clear expectations, they are more likely to stay on task and engage in the learning.

OBSERVATION FORM
REVERSIBLE CHANGES

NAME: _____
DATE: _____

Object we are investigating: _____

We are applying (circle one): heat cold

Before

What are the characteristics of your object before you heat or cool it?

After

What are the characteristics of your object after you heat or cool it?

Reverse

What are the characteristics of your object after you try to reverse the changes?

Note: Record both quantitative data (things you can measure) and qualitative data (things you can describe).

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Observation Form

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM



Data Analysis

Students make sense of their data by organizing it and representing it visually.

As a class, have students analyze the data (the characteristics they listed for the objects) for all the different materials tested. You may wish to use the [Data Analysis](#) prompt as a guide.

- Have students **evaluate** their data for trustworthiness. Did they record observations objectively and truthfully?
- Then, have them analyze their data to find patterns and trends. They may **organize** the data and/or **represent** it visually to construct meaning. You may want to make a T-Chart with "Changed Back" and "Did Not Change Back," and as each group presents their data, add the object and its change to the chart in the appropriate column. (For example "Water changed to ice and changed back to water" in the "Changed Back" column.) If photos were taken, incorporate the photos in the data analysis.
- Have students **interpret** what the identified patterns mean. They should discern that some changes caused by heating or cooling can be reversed and other changes cannot.
- Ensure students have enough data that it can be used as evidence to support a claim.



Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from the analyzed data to write an explanation that answers their investigation question. You may wish to use the [Explanation](#) prompt as a guide. You may want to create a class explanation as a *Shared Writing* activity.
- Have students review the investigation question: When things are changed by heat or cold, can they be changed back?
- Have students develop a **claim** to answer the investigation question.
- Then, have them write down the **evidence** that supports their claim.
- Finally, have them add **reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

Some things that were changed by heat or cold could be changed back. Others could not.

Evidence

Our class applied cold and heat to different objects and observed how the objects changed. Then, we tried to change the objects back. We were able to change some objects back, but not other objects.

We added cold to these objects: water, butter, a plant leaf, an apple, a cup of soup, and a slice of bread. We were able to reverse the change in the water, butter, soup, and slice of bread. We were not able to reverse the change in the leaf or the apple.

We added heat to these objects: ice, butter, chocolate, egg, soup, and cookie dough. We were able to reverse the change in the ice and butter. We were not able to reverse the change in the chocolate, egg, or cookie dough.

Reasoning

We had a clear investigation plan and we followed it carefully. We discovered that some changes caused by heating or cooling could be reversed. For example, the ice we heated up melted into water. But we were able to freeze it and turn it back into ice. Other changes were not able to be reversed. For example, when we heated a raw egg, it became scrambled eggs. Even though we cooled the scrambled eggs down, we were not able to change it back to a raw egg.

(Note: This is a sample explanation. Actual results will depend on the methodology used to heat and cool the objects.)

COLLABORATION

Explain that this investigation question required testing several objects in order to collect enough evidence to make a claim. Discuss how you were able to save time by having different groups test different objects and then sharing data. Explain that scientists do this, too. They regularly collaborate and share what they learn to help answer their questions.



Evaluation

Students reflect on the investigation.

Ask students:

- *What other items would you like to test?*
- *How confident are you in our claim?*

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION



Application

Students demonstrate understanding of how some changes caused by heating or cooling can be reversed and others cannot.

- Have students use what they learned from their investigation to re-write the lyrics to the chorus of the song, "Changes" in the movie *Shrek 2*.
- Ask students to plan a menu that consists entirely of things that can be frozen and then reheated. Or give them a sample menu, and ask them to predict which things can be frozen and reheated and which can't, based on what they've learned.
- Have students read *The Secrets of Heat and Cold* to learn more about the effects of heating and cooling.

Assessment

Evaluate for how well:

- students describe the characteristics of a material before heating/cooling is applied, after heating/cooling is applied, and after heating/cooling is reversed.
- students use evidence to determine and describe which changes to an object made by heating or cooling can be reversed and which cannot.

Take This Lesson Across the Curriculum

Wonderful Water

We see it every day, and yet we don't always stop to appreciate the wonder of water. Imagine an alien from a planet that has no water came to visit. How would you explain the wonder of water?

Reading/Language Arts	Math	Science	Social Studies
<p>Water in Photos</p> <p>Read a portion of <i>A Drop of Water</i>, by Walter Wick and encourage students to discuss the wonder-filled photography.</p> <p>CCSS.ELA-LITERACY.RI.2.10</p>	<p>Water by the Numbers</p> <p>Figure out how many glasses of water your class drinks in one week. Have another class do the same. Compare which class drinks more or less.</p> <p>CCSS.MATH.CONTENT.2.OA.A.1</p>	<p>Reversible Changes</p> <p>Discover how temperature changes can cause water to change into different states and back again.</p> <p>NGSS: 2-PS1-4</p>	<p>World of Water</p> <p>Look at world maps and see just how much of the world is covered in water!</p> <p>NCSS: D2.Geo.2.K-2</p>

Superhero by Design

The ability to change into something and then change back could be the ultimate superpower. Design a superhero with this unique ability. What things can he or she change? How would he or she use this power to save a city in danger?

Reading/Language Arts	Math	Science	Social Studies
<p>Save the City</p> <p>Write a story where a city is in danger and your superhero saves it by changing something and then reversing the change.</p> <p>CCSS.ELA-LITERACY.W.2.3</p>	<p>A Little Bit at a Time</p> <p>Draw your story's city as a circle or rectangle. Then, draw lines to explain how your superhero saves one section of the city at a time (one third, two thirds, three thirds!).</p> <p>CCSS.MATH.CONTENT.2.G.A.3</p>	<p>Reversible Changes</p> <p>Discover how temperature changes can cause water to change into different states and back again.</p> <p>NGSS: 2-PS1-4</p>	<p>It Takes a Team</p> <p>What city officials help your superhero in saving the city? What are their roles and responsibilities?</p> <p>NCSS: D2.Civ.1.K-2.</p>

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.



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INVESTIGATION PLAN

REVERSIBLE CHANGES

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We are applying (circle one): heat cold

1. Observe your object. Describe its characteristics. Record your observations in the "Before" section of the **Observation Form**.
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_____.
3. Observe your object again. Describe its characteristics. Record your observations in the "After" section of the **Observation Form**.
4. Try to reverse the change by _____

_____.
5. Observe your object again. Describe its characteristics. Record your observations in the "Reverse" section of the **Observation Form**.

OBSERVATION FORM

REVERSIBLE CHANGES

NAME: _____

DATE: _____

Object we are investigating: _____

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Before

What are the characteristics of your object before you heat or cool it?

After

What are the characteristics of your object after you heat or cool it?

Reverse

What are the characteristics of your object after you try to reverse the changes?

Note: Record both quantitative data (things you can measure) and qualitative data (things you can describe).