This lesson is one approach to teaching the State Standards associated with this unit. Districts are encouraged to customize this lesson by supplementing with district-approved resources, materials, and activities to best meet the needs of learners. The duration for this lesson is only a recommendation, and districts may modify the time frame to meet students’ needs. To better understand how your district may be implementing CSCOPE lessons, please contact your child’s teacher. (For your convenience, please find linked the TEA Commissioner’s List of State Board of Education Approved Instructional Resources and Midcycle State Adopted Instructional Materials.)

Lesson Synopsis

Students will be investigating and predicting the changes that can occur in the states of matter when heat is added or removed. They will focus on understanding where the transfer of energy occurs.

TEKS

The Texas Essential Knowledge and Skills (TEKS) listed below are the standards adopted by the State Board of Education, which are required by Texas law. Any standard that has a strike-through (e.g., sample phrase) indicates that portion of the standard is taught in a previous or subsequent unit. The TEKS are available on the Texas Education Agency website at [http://www.tea.state.tx.us/index2.aspx?id=6148](http://www.tea.state.tx.us/index2.aspx?id=6148).

4.5 Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:

4.5A Measure, compare, and contrast physical properties of matter, including size, mass, volume, states (solid, liquid, gas), temperature, magnetism, and the ability to sink or float.

4.5B Predict the changes caused by heating and cooling such as ice becoming liquid water and condensation forming on the outside of a glass of ice water.

Scientific Process TEKS

4.1 Scientific investigation and reasoning. The student conducts classroom and outdoor investigations, following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

4.1A Demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations.

4.2 Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and outdoor investigations. The student is expected to:

4.2A Plan and implement descriptive investigations, including asking well-defined questions, making inferences, and selecting and using appropriate equipment or technology to answer his/her questions.

4.2B Collect and record data by observing and measuring, using the metric system, and using descriptive words and numerals such as labeled drawings, writing, and concept maps.

4.2D Analyze data and interpret patterns to construct reasonable explanations from data that can be observed and measured.

4.2F Communicate valid, oral, and written results supported by data.

4.4 Scientific investigation and reasoning. The student knows how to use a variety of tools, materials, equipment, and models to conduct science inquiry. The student is expected to:

4.4A Collect, record, and analyze information using tools, including calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, mirrors, spring scales, pan balances, triple beam balances, graduated cylinders, beakers, hot plates, meter sticks, compasses, magnets, collecting nets, and notebooks; timing devices, including clocks and stopwatches; materials to support observation of habitats of organisms such as terrariums and aquariums.

GETTING READY FOR INSTRUCTION

Performance Indicators
Key Understandings

- The addition or reduction of heat may cause predictable changes predictable in the states of matter.
  - What happens to matter when it is “cooled down”?
  - What changes can occur when heat is added to a substance?
  - What changes can occur when heat is removed from a substance?

Vocabulary of Instruction

- heat
- energy
- heat transfer
- condensation
- melting
- freezing

Materials

- book (on the water cycle, 1 per class)
- chart paper (per class)
- colored pencils (1 box per 2 students)
- cup (clear, 2 per group)
- cup of ice water (plastic, 6-8 ounce, 1 per class)
- food coloring (any color, per class)
- food coloring (blue and yellow, 1 container of each per class)
- hot plate (1 per class)
- hot water (per group)
- ice (per class)
- ice water (per group)
- markers (1 set per teacher)
- mirror (about 4 x 6 inches, 1 per class)
- paper (per class)
- small pot (1 per class)
- thermometer (1 per group)
- timer (1 per group)

Attachments

All attachments associated with this lesson are referenced in the body of the lesson. Due to considerations for grading or student assessment, attachments that are connected with Performance Indicators or serve as answer keys are available in the district site and are not accessible on the public website.

- Handout: Comparing Hot and Cold (1 per student)
- Handout: Icy Plans (1 per student)
- Teacher Resource: Heat Can Cause Change
- Teacher Resource: Heat Can Cause Change KEY
- Handout: Water on the Move (1 per student)
- Teacher Resource: Water on the Move KEY
- Teacher Resource: Transfer of Heat KEY
- Teacher Resource: PowerPoint: The Impact of Changes by Heating or Cooling
- Handout: Department of Matter Job Vacancy PI (1 per student)
- Optional Teacher Resource: Example of Super Hero Sample PI

Resources

None Identified

Advance Preparation
1. Create a T-chart to record student responses on Changes Caused by Heating and Changes Caused by Cooling in the Explore section.
2. Print enough copies of the Teacher Resource: Heat Can Cause Change on sturdy paper so that each student in the class will get one picture. Cut out the pictures so they are ready for distribution during the activity. Two or three students will have the same picture.
3. Prepare attachment(s) as necessary.

Background Information

This lesson bundles SE’s that address the changes caused by heating and cooling such as ice becoming liquid water and condensation forming on the outside of a glass of ice water. In Grade 4, students will be focusing on specific examples of changes caused by heating and cooling while investigating more deeply why this occurs (transfer of heat energy).

STAAR Note:

Although neither of the content standards addressed in this unit are Supporting Standards, the content will directly provide foundation for Readiness Standard 5.5A and Supporting Standard 5.5B.

INSTRUCTIONAL PROCEDURES

<table>
<thead>
<tr>
<th>Instructional Procedures</th>
<th>Notes for Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGAGE – Comparing Hot and Cold</td>
<td>NOTE: 1 Day = 50 minutes</td>
</tr>
<tr>
<td>1. Divide the class into groups of four students. Provide each group with the Handout: Comparing Hot and Cold, two cups, a timer, and a thermometer. Distribute the ice water and the hot water to each group.</td>
<td>Suggested Day 1</td>
</tr>
<tr>
<td>2. Safety Note: Be sure to inform students to not touch the hot water. Review any other safety concerns at this time.</td>
<td></td>
</tr>
<tr>
<td>3. Instruct students to measure the temperature of each cup of water using the thermometer and record the temperature (in °C) on their Handout: Comparing Hot and Cold. (Remind students that the thermometer will need to stay in the cup of water for at least three minutes.)</td>
<td>Materials:</td>
</tr>
<tr>
<td>4. Place one drop of yellow and one drop of blue food coloring into the cup of ice water for each group. Instruct students to draw their observations on the Handout: Comparing Hot and Cold on the appropriate cup. Students should also describe their observations.</td>
<td>- cup (clear, 2 per group)</td>
</tr>
<tr>
<td>5. Repeat the process of adding food coloring drops and making observations for the hot water cups.</td>
<td>- ice water (per group)</td>
</tr>
<tr>
<td>6. Facilitate a conversation about changes in the food coloring that were observed in the ice water and then the changes in the food coloring that were observed in the hot water.</td>
<td>- hot water (per group)</td>
</tr>
<tr>
<td>7. Explain to students that during the next few science classes they will be looking at how substances react when heat is added or removed.</td>
<td>- thermometer (1 per group)</td>
</tr>
<tr>
<td>8. Instruct students on the disposal of the water and clean up procedures. The cups can be dried and saved for other science investigations.</td>
<td>- timer (1 per group)</td>
</tr>
<tr>
<td>Attachments:</td>
<td>- food coloring (blue and yellow, 1 container of each color per class)</td>
</tr>
<tr>
<td>- Handout: Comparing Hot and Cold (1 per student)</td>
<td>- colored pencils (per group)</td>
</tr>
</tbody>
</table>

Safety Notes:

Discuss with students the procedures for cleaning up a spill. Be sure to inform students to not touch the hot water.

Instructional Notes:

When distributing the ice water, ensure that the cups are filled with water only, no ice.

Students may think that heat is not energy.

Misconception:

- Students may think that temperature is a property of a particular material or object (Metal is naturally colder than plastic to most students.).

Science Notebooks:

Students should write a three sentence reflection about their observations and the discussion about the changes that occurred.
1. Instruct students to create a T-chart in their science notebook. Label one side *Changes Caused by Heating* and the other *Changes Caused by Cooling*.

| *Changes Caused by Heating* | *Changes Caused by Cooling* |

2. Facilitate a discussion about changes to matter:
   - What are some changes to matter you have observed that were caused by adding heat?
   - Write your thoughts in the *Changes Caused by Heating* column.
   - What are some changes to matter you have observed that were caused by removing heat?
   - Write your thoughts in the *Changes Caused by Cooling* column.

3. Allow time for students to share their responses. Chart their responses where they can be seen and used as a reference throughout the lesson.

4. Divide the class into groups of three to four students. Instruct students to plan a descriptive investigation on how to change ice to liquid water. Their plan should include a question, materials, a procedure and observation.

5. Provide instructions for the investigation:
   - As you are planning your investigation you need to remember to address the problem: How can I change ice to liquid water?
   - The materials you choose should be readily available in our classroom.
   - Remember that the chart we just created may help your group develop a plan.

6. Students should have about five minutes to discuss their plan. As students discuss a plan, distribute the Handout: *Icy Plans* to each student.

7. Students should complete the Handout: *Icy Plans* through the materials and procedure section.

8. Collect the plans in order to review materials and procedures. The materials will need to be available for students for the next class.

---

**EXPLAIN – Icy Plans**

1. Allow students time to complete their investigation and the Handout: *Icy Plans*.

2. Choose one member from each group to briefly explain what they did to change the ice into water.

3. Facilitate a discussion about heat causing ice to change to water. Hold up a cup of ice so students can see it. (Note: Do not read these answers to the students, they will discover the answers during the demonstration.)
   - What will happen if I leave this on a table for several minutes? The ice will begin to melt.
   - Will there be any other changes other than the change in ice from a solid to a liquid? Yes, the temperature of the water/ice mixture will be higher than the temperature of just the ice. Condensation will form on the outside of the cup.
   - What is the temperature of the ice in the cup? It should be close to 0°C.

4. Place the thermometer in the cup of ice. After three minutes, choose a student to read and record the actual temperature. Add a few drops of food coloring to the ice. (The food coloring is so that the water is a different color in the cup, so only a few drops are needed. As condensation forms on the outside of the cup it will be colorless. Some students think that the water passes through the cup and collects on the outside of the cup. The colored water in the cup refutes this...
concept.) Return the thermometer to the ice water.

5. Provide instructions for students:
   - In your science notebook, draw how the cup looks now and then draw another illustration of how the cup will look in 15 minutes.

6. After 15 minutes, allow students to observe the cup and get a reading from the thermometer. Students should have the opportunity to answer/reflect on the following questions in their science notebooks.
   Ask:
   - What caused the water to form on the outside of the cup? Answers may vary; however, it is because the water vapor in the atmosphere cools down and condenses on the outside of the cup.
   - What caused the water to melt? Heat energy from the room transferred to the ice. The ice gains heat and melts.
   - What would happen if I added more heat to the ice water? The first change caused by adding more heat would be the ice melts and changes from a solid to a liquid. With the addition of more heat the water would change from a liquid to a gas as the temperature rises to 100°C.
   - What are other changes in matter that are caused by heating? Answers will vary.

### EXPLORE – Heat Can Cause Change

1. Distribute one picture from the Teacher Resource: Heat Can Cause Change to each student.
2. On your signal, instruct students to find another student(s) who has the same picture.
3. When students are in pairs, provide the following instructions:
   - Once you have found another student(s) who has the same picture as you, discuss the object’s physical properties that can be observed and described from the picture, and predict the changes in the object shown caused by heating.
4. After a few minutes to communicate their thinking, students should return to their seats. Distribute a blank sheet of paper to each student. Instruct students to draw a prediction about the changes in the object caused by heating. A suggested format is to fold the paper in half and have a picture of the object before heating on the left and then the object with changes caused by heating on the right.

5. After students have completed the illustrations, facilitate a discussion on heat causing change:
   - Each of you drew an illustration to show how adding heat to matter can cause change.
   - If I have a corn kernel and I add heat, how does the corn kernel change? (It “pops” and makes popcorn.)
   - If I remove the heat, or cool the popcorn down, will it change back into a corn kernel? (No)
   - Look at the pictures you drew of the change caused by heat. If you cooled the item, would it change back into the original item?

### Materials:
- paper (blank, 1 sheet per student)

### Attachments:
- Teacher Resource: Heat Can Cause Change
- Teacher Resource: Heat Can Cause Change KEY

### Misconception:
- Students may think heat and temperature are the same.
6. Record student responses to the question. A chart could be used to organize the information. See the Teacher Resource: **Heat Can Cause Change KEY**.

7. Students should be gaining the understanding that adding heat can cause changes in the properties of materials (matter) but not all materials respond the same way to being heated.

8. As a summary of the day’s investigation, students should write or draw their understanding of the changes in matter caused by heating. This could include melting, evaporating, or cooking. Additionally, instruct students to answer the questions:
   - What tool would you use to indicate that heat has been added? (Thermometer)
   - What changes can occur when heat is added to a substance? Answers will vary.

### EXPLAIN – Water on the Move

1. Read a book about the water cycle.

2. Distribute the Handout: **Water on the Move** to each student.

3. After reading the book, hold up a cup, filled with ice water, with condensation formed on the outside. Review the parts of the water cycle:
   - What part of the water cycle is demonstrated by this cup of ice water? *Students should recall that the condensation on the outside of the glass is similar to what takes place in clouds.*

4. Pour the water into a small pot or heat proof container and place it on a hot plate. Continue the review of the water cycle:
   - When I pour the water into the pot (or container), what part of the water cycle is demonstrated? *Students should recall that when water falls from the atmosphere it is called precipitation. In this case the water would represent rain and the ice could represent either hail or sleet.*

5. Turn on the hotplate to heat the water. Continue the review of the water cycle:
   - What part of the water cycle is demonstrated by heating the water? (Evaporation)
   - What happens to the water vapor? *(It rises to the atmosphere and condenses as it cools.)*
   - What are examples of evidence that the water vapor exists? *Answers may vary, but should include that you can see the ‘steam’ rising from the pot.*

6. As the water is heating, instruct students to begin completing the Handout: **Water on the Move**. Students will need to fill in the boxes with appropriate information as it relates to the heating and cooling of water. The Teacher Resource: **Water on the Move KEY** can be used as a guide.

7. When the water boils in the pot, take the temperature of the water with the thermometer. Read the temperature to the students. They should record the temperature (in °C) next to the evaporation on the Handout: **Water on the Move**. Safety Note: Use care when removing the thermometer from the pot of boiling water to read the temperature. A student should **NOT** remove the thermometer.

8. Hold the mirror in the path of the water vapor rising from the pot. The water droplets will condense quickly on the mirror. Hold the mirror up for students to see. Relate the demonstration to everyday life:
   - What are some everyday situations you have experienced that demonstrate the change of water by cooling? (Instruct students to think about what they are seeing right now.) Answers may vary, but might include a mirror fogging up in the bathroom, windows having water condense on them on a humid day, or eyeglasses fogging up.

### Suggested Day 4

**Materials:**
- book (on the water cycle, 1 per class)
- cup of ice water (plastic, 6-8 ounce, 1 per class)
- hot plate (1 per class)
- small pot (1 per class)
- mirror (about 4 x 6 inches, 1 per class)

**Attachments:**
- Handout: **Water on the Move** (1 per student)
- Teacher Resource: **Water on the Move KEY**
- Teacher Resource: **Transfer of Heat KEY**

**Safety Notes:**
Use care when removing the thermometer from the pot of boiling water to read the temperature. A student should **NOT** remove the thermometer.

Teachers need to ensure that the thermometer they are using measures to 100°C.

**Instructional Notes:**
- The cup with ice water should have condensation on the outside.
- Although the water cycle will not be directly taught and reinforced until Unit 06, students have had the opportunity to learn about this concept in Grades 2 and 3.
- To reinforce the concept that addition of heat can be demonstrated by using a thermometer, place a thermometer in the pot of ice water before heating and again after the water begins to boil.
- When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point of water. Clouds and fog are made of tiny droplets or frozen crystals of water.
9. Turn off the heat on the hotplate, and unplug the unit.


1. Students should affix the handout in their science notebook and then complete a reflection about the transfer of heat. The reflection should include:
   - what happens to solid water (ice) when heat is added
   - what happens to liquid water when heat is added
   - what happens to water in the gaseous state when it is cooled
   - what happens to liquid water when it is cooled

2. The Teacher Resource: Transfer of Heat KEY has suggested answers.

The teacher should emphasize that "cooling" is a reduction in, or removal of, heat.

✅ Check For Understanding:
The reflection is an opportunity for the teachers to informally assess the student’s understanding of changes in water by cooling and changes in water by heating.

Science Notebooks:
Students should affix the handout in their science notebook and then complete a reflection, in writing and/or pictures, about the transfer of heat. The reflection should include:
   - what happens to solid water (ice) when heat is added
   - what happens to liquid water when heat is added
   - what happens to water in the gaseous state when it is cooled
   - what happens to liquid water when it is cooled

ELABORATE – Changes by Heating or Cooling in Everyday Life

1. Remind students that over the past few days they have been studying the changes that occur to water when heat is added or reduced. Today we will observe the many ways that the addition or reduction of heat impacts our daily lives and the Earth.

2. Show Teacher Resource: Power Point: The Impact of Changes by Heating or Cooling.

3. Instruct students to reflect in their science notebook how changes in the states of matter caused by the addition or reduction of heat affect their everyday lives.

Suggested Day 5

Attachments:
- Teacher Resource: Power Point: The Impact of Changes by Heating or Cooling

Science Notebooks:
Students will reflect in their science notebook how changes in the states of matter caused by the addition or reduction of heat affect their everyday lives.

EVALUATE – Performance Indicator

Suggested Day 6

Materials:
- paper (plain, 1 sheet per student)
- colored pencils (1 box per 2 students)

Attachments:
- Handout: Department of Matter Job Vacancy PI (1 per student)
- Optional Teacher Resource: Example of Super Hero Sample PI

Grade 04 Science Unit 01 PI 03
Create an illustration, and develop a story about a superhero with the ability to change the state of matter, using the addition or reduction of heat.

Standard(s): 4.2F, 4.5B
ELPS, ELPS.c.1C, ELPS.c.3I, ELPS.c.5E

1. Distribute a copy of the Handout: Department of Matter Job Vacancy PI, or project one copy for the class to read and review together.

2. Allow students time to read through the Handout: Department of Matter Job Vacancy PI.

3. Share Performance Indicator rubric or expectations with students prior to students beginning the assessment.

4. Answer any questions students may have regarding the assessment.
Comparing Hot and Cold

Hot Water

<table>
<thead>
<tr>
<th>Temperature:</th>
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</table>

<table>
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<tr>
<th>Observations:</th>
</tr>
</thead>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

Cold Water

<table>
<thead>
<tr>
<th>Temperature:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observations:</th>
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</tr>
</tbody>
</table>
Icy Plans

Problem: How can I change ice to liquid water?

Write a testable question about what you think will happen and why:

Materials:  

Procedure:
1.
2.
3.
4.
5.

Observations:  

Drawing of investigation including how the heat was transferred:

Follow-up Questions:

1. What state of matter was the ice cube in at the beginning of the investigation? ________________

2. What state of matter was the ice cube in at the end of the investigation? ________________

3. What was the cause of the change in matter?

___________________________________________________________________________________

Name:

Date:
# Heat Can Cause Change

<table>
<thead>
<tr>
<th>egg</th>
<th>cheese</th>
<th>candle</th>
</tr>
</thead>
<tbody>
<tr>
<td>taffy</td>
<td>ice cream</td>
<td>marshmallows</td>
</tr>
<tr>
<td>chocolate</td>
<td>ice cubes</td>
<td>butter</td>
</tr>
<tr>
<td>bread</td>
<td>crayons</td>
<td>popsicle</td>
</tr>
</tbody>
</table>
# Heat Can Cause Change

<table>
<thead>
<tr>
<th>Object</th>
<th>Heat changed it by…</th>
<th>Cooling will reverse the changes by heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>Cooking it</td>
<td>No</td>
</tr>
<tr>
<td>Cheese</td>
<td>Melting</td>
<td>Maybe - It depends upon the variety of cheese.</td>
</tr>
<tr>
<td>Candle</td>
<td>Melting</td>
<td>Yes - But only in the sense that melted wax will cool and form hardened wax</td>
</tr>
<tr>
<td>Taffy</td>
<td>Melting</td>
<td>Maybe - It will not necessarily have the same shape.</td>
</tr>
<tr>
<td>Ice Cream</td>
<td>Melting</td>
<td>Maybe - It will not necessarily have the same shape nor the same texture.</td>
</tr>
<tr>
<td>Marshmallows</td>
<td>Cooking</td>
<td>No</td>
</tr>
<tr>
<td>Chocolate</td>
<td>Melting</td>
<td>Yes</td>
</tr>
<tr>
<td>Ice Cubes</td>
<td>Melting</td>
<td>Yes</td>
</tr>
<tr>
<td>Butter</td>
<td>Melting</td>
<td>Yes</td>
</tr>
<tr>
<td>Bread</td>
<td>Toasting</td>
<td>No</td>
</tr>
<tr>
<td>Crayons</td>
<td>Melting</td>
<td>Yes - Though they may have a different shape, they can still be used for coloring</td>
</tr>
<tr>
<td>Popsicle</td>
<td>Melting</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Water on the Move

[Diagram of water cycle with labels for stages: evaporation, condensation, precipitation, and collection.]
Water on the Move

Water condenses on outside of cup.

Water condenses in clouds.

Precipitation (rain, hail, sleet, snow)

Evaporation

Addition of heat.

Cooling of the water vapor.

Sun
Transfer of Heat KEY

Department of Matter Job Vacancy PI

The Department of Matter is looking for super heroes. The department needs super heroes who have the power to remove heat from matter, and it needs super heroes who have the power to add heat to matter. Sometimes matter needs to be melted and other times it needs to be frozen. The Department of Matter needs to have a team of super heroes who can add or remove heat in order to change matter. These super heroes will help the citizens on Earth by changing matter that is used every day.

Do you know of any heroes who fit the description?

Send their resumes, with a description of their power, and include a current picture. Send these to the Department of Matter for review. Remember, the world needs you!

Your job is to describe a super hero who will meet the needs of the Department of Matter.

The description should include:
- Your super hero’s name.
- Does the super hero add or remove heat?
- The changes caused by the addition of heat or by the cooling.
- Who will benefit from the super hero’s abilities?

In addition, there should be a description of a scenario where the super hero has made a change; what was it like before the change and after the change.

Your writing needs to be in complete sentences, and your writing should be creative.

You need to illustrate and color your super hero. Label the equipment that helps your super hero to complete his or her special jobs.
Example of Super Hero: 
The Heat Absorber Sample PI

This super hero is important because he can absorb heat from any form of matter. He is a better conductor of heat than any other Earthly material. This makes him useful for absorbing heat in dangerous situations.

One upon a time, in Guatemala, the locals received a warning that the volcano Sangay was about to erupt. The villagers were poor, and many of them had no way to escape before the volcano erupted and lava flowed into the village. The Heat Absorber was summoned to the location. Within minutes, he had climbed to the mouth of the volcano. He swung his conductor sword from its sheath and placed it in the mouth of the volcano. Instantly the sword turned redish-orange and began to glow. It was conducting the heat away from the volcano and onto the Heat Absorber. He slowly began to glow, and within a few minutes, the magma from the volcano stopped rising. The Heat Absorber stopped glowing. He walked back down the volcano and told the villagers it was now safe. He had transferred all of the heat from the volcanic lava into his own body. The loss of heat caused the lava to turn into solid volcanic rock called igneous rock. There was no longer a danger from the volcano from the flowing lava because the reduction of heat caused the lava to turn from molten rock (a liquid) to igneous rock (a solid).

Without The Heat Absorber, the village would have been destroyed and thousands of villagers would have lost their lives. The Heat Absorber would make a great addition to the Department of Matter.