Thermal Energy

Physical Science | Lesson Guide

2nd Grade

Photo Description

This image shows an egg cooking on a dark pan over a blue flame on a stove. The egg white has turned from clear to solid white, while the yellow yolk in the middle stays runny. Heat from the flame below is making the egg change from raw to cooked.

Scientific Phenomena

Anchoring Phenomenon: Heat energy changes the properties of matter (specifically, egg proteins denature and solidify when exposed to thermal energy).

When heat from the flame travels to the pan and then to the egg, it causes the proteins in the egg white to break apart and bond in new ways. This physical and chemical change makes the clear, liquid egg white become solid and opaque. The yolk heats more slowly because it's thicker, so it may stay liquid longer. This is an everyday example of how thermal energy (heat) can permanently transform materials.

Core Science Concepts

* Heat and Temperature: Heat is energy that moves from hot things to cooler things. The flame is very hot and transfers heat to the pan and egg.

* States of Matter: Matter can exist as solids, liquids, or gases. The egg changes from a liquid (raw) to a solid (cooked) when heat is added.

* Energy Transfer: Thermal energy moves in a direction—from the hot flame !' to the pan !' to the egg. This is called heat transfer.

* Irreversible Changes: Once an egg is cooked, you cannot turn it back into a raw egg. This shows that some changes caused by heat are permanent.

Pedagogical Tip:

Use a sensory prediction strategy before showing the cooking process. Ask students, "If you could touch this raw egg, what would it feel like?" Then ask, "What do you think it will feel like after the heat touches it?" This activates prior knowledge and builds curiosity before the lesson begins.

UDL Suggestions:

Multiple Means of Engagement: Provide a raw egg and a cooked egg for students to observe and touch (with appropriate safety and hand-washing). Offer visual, tactile, and olfactory experiences. For students with sensory sensitivities, provide photos or drawings as alternatives to direct contact.

Multiple Means of Representation: Use both words and pictures to describe the egg cooking. Act out the changes: have students stand (liquid) and then "freeze" in place (solid) to show the change from raw to cooked.

Zoom In / Zoom Out

Zoom In: The Microscopic Level
When heat is added to an egg, something invisible is happening to the proteins inside. Proteins are teeny-tiny building blocks made of even smaller parts called atoms. When heat makes the egg get hot, these atoms start to jiggle and move around faster and faster—like kids running around at recess instead of sitting still in class. When atoms jiggle so much, the proteins break apart and stick back together in new ways. This is why the clear liquid egg white becomes thick and white and solid. You can't see the atoms moving, but the heat is making them dance!

Zoom Out: The Kitchen System
A stove is part of a bigger system in your home that brings heat and energy to cook meals for your family. Natural gas or electricity powers the stove, which creates the blue flame. The flame heats the pan, the pan heats the egg, and the cooked egg becomes food for people to eat. This connects to farms where chickens lay eggs, trucks that deliver eggs to stores, grocery stores where families buy eggs, and kitchens where people prepare meals. Heat energy is part of a whole chain that goes from the farm to your table!

Discussion Questions

1. What do you notice has changed about the egg after heat was added? (Bloom's: Remember | DOK: 1)
2. Why do you think the egg white turned from clear to white? (Bloom's: Analyze | DOK: 2)
3. If we could cool down the cooked egg, do you think it would turn back into a raw egg? Why or why not? (Bloom's: Evaluate | DOK: 3)
4. Where is the heat coming from, and how does it reach the egg? (Bloom's: Understand | DOK: 2)

Potential Student Misconceptions

Misconception 1: "Heat is a thing, like water, that flows into the egg."
Clarification: Heat is not a "thing" you can hold—it's energy that moves from hot things to cooler things. The flame has a lot of thermal energy. This energy moves (or transfers) from the hot flame to the cooler pan, and then to the cooler egg. It's like a game of tag where energy passes from one object to the next!

Misconception 2: "If we cool down the cooked egg in the freezer, it will turn back into a raw egg."
Clarification: Cooling an egg down will make it hard and cold, but it will not undo the cooking. The proteins in the egg have permanently changed their shape and connections. Cooling can reverse some changes (like melted ice cream turning back into solid ice cream), but cooking is different—it's an irreversible change that cannot be undone just by making something cold again.

Misconception 3: "The yellow part of the egg (yolk) cooks faster than the white part because it's hotter."
Clarification: Actually, the egg white usually cooks faster and becomes solid first. The yolk cooks more slowly because it's thicker and denser, so heat takes longer to travel all the way through it. Both parts are getting heat from the pan, but the heat spreads through the thinner white part first.

Extension Activities

Activity 1: Cooking Sequence Cards
Provide three pictures showing an egg in different stages: raw, cooking, and fully cooked. Ask students to place them in order and explain what is happening at each stage using their new vocabulary.

Activity 2: Heat Source Exploration
Safely explore other heat sources in the classroom (a sunny windowsill, a lamp, warm water). Have students predict and test which sources are warm and which are cool. Create a class chart showing "Warm" and "Cool" heat sources.

Activity 3: Material Changes Hunt
Take students on a "material changes" walk through the school or home (with permission). Identify other examples of irreversible changes caused by heat: toast, melted butter, baked cookies, or heated playdough. Document with drawings and discuss why these changes are permanent.

Cross-Curricular Ideas

Math Connection: Cooking Time & Measurement
Have students time how long it takes to cook an egg (with adult supervision or using video). Create a simple chart showing "0 minutes" (raw), "2 minutes" (cooking), and "4 minutes" (fully cooked). Students can use a timer or sand timer and practice measuring elapsed time. You could also compare cooking times for different foods and create a bar graph titled "How Long Does It Take to Cook?"

ELA Connection: Sequence Writing & Recipe Language
Guide students to write or illustrate a simple recipe for a cooked egg using sequence words: "First, the egg is raw. Next, heat from the stove makes it warm. Then, the white part turns solid. Finally, the egg is ready to eat!" This introduces procedural writing and the importance of order and clear directions. Students can draw pictures for each step and dictate or write captions.

Art Connection: Color & State Changes
Have students create a visual transformation using colored pencils or watercolors. They draw the same egg three times—raw (clear whites, yellow yolk), cooking (milky whites, yellow yolk), and cooked (solid white, solid yellow). This reinforces the concept of irreversible change while allowing creative expression. Display the series on a bulletin board titled "Heat Changes Matter."

Social Studies Connection: Cultural Foods & Family Cooking
Discuss how families from different cultures cook eggs in different ways (fried, boiled, scrambled, baked in cakes). Have students share or draw their favorite way to eat eggs at home. This builds community, celebrates diversity, and connects science to real family life and cultural practices.

STEM Career Connection

Chef or Cook
A chef is someone who uses heat and different cooking techniques to prepare yummy food for people to eat. Chefs need to know how heat changes different foods and when food is ready to serve. They might work in restaurants, schools, hospitals, or hotels. Chefs use science every day when they decide how hot to make a stove, how long to cook something, and how different ingredients change when heated.
Average Annual Salary: $32,000–$45,000 USD

Food Scientist
A food scientist studies how food changes when it's cooked, stored, or mixed with other things. Food scientists work in laboratories and test different ways to cook food so it's safe, healthy, and tasty. They might figure out how to make food last longer, how heat affects the nutrients in eggs and other foods, or how to create new food products. Their work helps families eat healthy meals.

Average Annual Salary: $65,000–$75,000 USD

Thermal Engineer
A thermal engineer designs and builds machines and systems that use heat, like ovens, stoves, refrigerators, and heating systems in homes. Thermal engineers understand how heat moves and how to control it. They might create a better stove that cooks food more evenly or a kitchen that stays at the right temperature. Their work makes cooking safer and more efficient for everyone.
Average Annual Salary: $70,000–$85,000 USD

NGSS Connections

Performance Expectation:
2-PS1-2: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Disciplinary Core Ideas:
- 2-PS1.A: Different properties are suited to different purposes.
- 2-PS3.A: Heat can be produced in many ways and can move from one place to another.

Crosscutting Concepts:
- Energy and Matter: Energy can be transferred from one object to another.
- Cause and Effect: Simple cause-and-effect relationships exist in everyday situations (heat causes changes in materials).

Science Vocabulary

* Heat: Energy that makes things warm or hot.
* Thermal Energy: The energy that comes from heat and makes things warm.
* Cook: To use heat to change the way food looks and feels.
* Solid: Matter that has a definite shape and does not flow (like a cooked egg white).
* Liquid: Matter that flows and takes the shape of its container (like a raw egg).
* Irreversible Change: A change that cannot be undone or reversed.

External Resources

Children's Books:
- Heat by Robin Nelson (Lerner Publications) – Simple, illustrated introduction to heat and thermal energy
- The Egg by M.P. Robertson – A story-based exploration of eggs and transformation
- Cooking with the Sun by Beth and George Geiger – Demonstrates how heat from the sun cooks food