Thermal Energy

Physical Science | Lesson Guide

5th Grade

Photo Description

This image shows a fried egg cooking on a dark skillet placed over a blue gas flame. The egg white has turned from clear to solid white, and the yolk remains yellow in the center. The heat from the flame below is causing the egg to change from its raw state to a cooked state.

Scientific Phenomena

Anchoring Phenomenon: Heat transfer and the effects of thermal energy on matter.

Why It's Happening: When the skillet sits over the flame, thermal energy (heat) from the burning gas transfers into the metal pan through conduction. The hot pan then conducts heat into the egg. This thermal energy causes the proteins in the egg white to denature (unwind and bond differently), making the clear, liquid egg white turn opaque and solid. This is an irreversible change—once cooked, the egg cannot return to its raw state. The yolk heats more slowly because it's covered by the thicker egg white, which insulates it slightly from direct heat.

Core Science Concepts

* Thermal Energy Transfer: Energy moves from a warmer object (the flame and pan) to a cooler object (the raw egg) until they reach equilibrium or the egg is removed.

* Conduction: Heat transfers directly through solid materials touching each other—the flame heats the metal pan, and the pan heats the egg by direct contact.

* States of Matter and Phase Changes: The egg white undergoes a chemical change (not just a physical change) when heated, demonstrating that temperature affects how matter behaves.

* Temperature vs. Heat: Temperature measures how fast particles are moving; heat is the energy that flows from hot to cold objects. The pan's high temperature causes heat to flow into the egg.

Pedagogical Tip:

When teaching this lesson, avoid the common misconception that "heat" and "temperature" are the same thing. Use this analogy: Temperature is like a speedometer (measuring speed), while heat is like the engine (the energy doing the work). Students often confuse these terms, so reinforce the difference repeatedly with concrete examples from their daily lives.

UDL Suggestions:

Multiple Means of Representation: Provide a labeled diagram showing the path of thermal energy from the flame !' pan !' egg, with arrows indicating heat flow direction. For students who learn better kinesthetically, have them physically act out heat transfer: one student as heat, moving from "hot zone" to "cold zone."

Multiple Means of Action & Expression: Allow students to document their observations of the cooking egg through drawings, written descriptions, or video recordings rather than requiring only written responses.

Zoom In / Zoom Out

Zoom In: The Microscopic Story
When you zoom in to the atomic level, you'd see that the egg white is made of long, twisted protein molecules. These proteins are like coiled springs. When thermal energy from the hot pan reaches them, the particles start vibrating and moving faster. This vibration causes the protein springs to unwind and tangle together with their neighbors—a process called denaturation. Once tangled, they can't unwind back to their original shape, which is why the egg white turns from clear and runny to opaque and solid. The yolk stays yellow because it has a different type of protein that denatures at a higher temperature, so it stays slightly softer even when the white is fully cooked.

Zoom Out: The Energy Cycle
If you zoom out to see the bigger picture, this cooking egg is actually part of a much larger energy journey. The natural gas burning in the flame came from fossil fuels (plants and animals that died millions of years ago and were buried underground). That energy originally came from the sun, which powered ancient plants. Those plants were eaten by animals, which became part of the food chain. Now, a chicken laid an egg, and a person is cooking it to eat it. When you eat that cooked egg, your body will use the thermal energy and chemical energy from the food to power your muscles, brain, and growth. So one cooked egg connects you to the sun, ancient life, modern agriculture, and your own body's energy system!

Discussion Questions

* What do you observe happening to the egg white as it cooks, and why do you think those changes are occurring? (Bloom's: Analyze | DOK: 2)

* If we removed the egg from the hot pan right now, would it go back to looking like a raw egg? Why or why not? (Bloom's: Evaluate | DOK: 3)

* Where is the thermal energy coming from in this picture, and how does it travel to reach the egg? (Bloom's: Understand | DOK: 2)

* How is cooking an egg similar to or different from melting an ice cube? What does this tell us about thermal energy? (Bloom's: Create | DOK: 3)

Potential Student Misconceptions

Misconception 1: "Heat and temperature are the same thing."
Clarification: Temperature tells us how hot something is (measured in degrees). Heat is the energy that flows from something hot to something cold. The pan has a high temperature, but heat is what actually moves from the pan into the egg. You can think of it this way: temperature is like measuring someone's speed with a speedometer, but heat is like the engine that's actually doing the work of moving the car.

Misconception 2: "Cooking an egg is just the same as melting ice—both are just changes that can be undone."
Clarification: Melting ice (solid !' liquid) is a reversible physical change—if you freeze the water again, you get ice back. But cooking an egg is an irreversible chemical change—the proteins permanently change their structure and bond differently. No amount of cooling will turn a cooked egg back into a raw egg. This is an important distinction: not all changes caused by heat are the same!

Misconception 3: "The flame directly heats the egg."

Clarification: The flame does not touch the egg directly in this picture. Instead, the thermal energy travels through conduction: flame heats the metal pan !’ pan heats the egg. The metal pan is the "middle person" that transfers the heat. This is why we use pans to cook with—they conduct heat from the flame to the food safely and evenly.

Extension Activities

Activity 1: Thermal Energy Investigation Station
Set up stations where students safely observe different materials being heated (with supervision): a piece of butter melting, chocolate softening, a sugar cube dissolving in hot water. Have students predict which materials will change reversibly vs. irreversibly, then record their observations. Discuss why some changes can be "undone" and others cannot.

Activity 2: Energy Tracking Challenge
Give students a card or worksheet tracing the energy path: "Where did the energy in this cooked egg come from?" Students draw or write the journey backward (sun !’ plant/grain !’ chicken !’ egg !’ your body). This connects to PS3-1 and helps them understand energy conservation across systems.

Activity 3: Design a Better Insulator
Challenge students to design a "blanket" (using foam, cloth, air pockets, etc.) that slows down heat transfer to an egg. Using identical eggs and heat sources, students test their insulators by measuring how long it takes for the egg white to set. Discuss which materials were best conductors vs. insulators.

Cross-Curricular Ideas

Math Connection: Measuring Heat Transfer
Students can conduct a timed experiment where they cook multiple eggs on pans at different temperatures (or different distances from heat) and measure how long it takes for the egg white to fully set. They can create line graphs showing the relationship between temperature (x-axis) and cooking time (y-axis), then write word problems based on their data: "If an egg takes 4 minutes to cook on high heat, how long might it take on medium heat?" This integrates data collection, graphing, and proportional reasoning.

ELA Connection: Procedural Writing & Persuasion
Have students write a detailed how-to guide for cooking a perfect fried egg, using precise scientific vocabulary (thermal energy, conduction, temperature, etc.). Then challenge them to write a persuasive letter to a younger student explaining why they should learn about heat transfer—perhaps convincing them that understanding cooking is understanding science! This builds procedural writing and argumentative skills while reinforcing science terminology.

Social Studies Connection: Food & Culture
Different cultures cook eggs in different ways (fried, boiled, baked, scrambled). Students can research how various cultures around the world prepare eggs and create a map or poster showing these traditions. Discuss how access to fuel sources (gas, wood, electricity) affects how people cook in different regions and communities. This connects thermal energy to human geography and cultural practices.

Art Connection: Color & Heat Visualization
Students can create an artistic heat map of the cooking egg using colored pencils, pastels, or paint—using warm colors (red, orange, yellow) to show where thermal energy is strongest and cool colors (blue, green) where it's weakest. They can also design a poster or comic strip that shows the journey of heat from the flame to the egg, making abstract thermal energy visible and creative. Display these artworks in the classroom as a visual reminder of heat transfer.

STEM Career Connection

Chef or Food Scientist
Chefs and food scientists use their understanding of thermal energy, temperature, and how heat changes food to create delicious meals and design new recipes. They know exactly how hot a pan needs to be and for how long to cook an egg perfectly. Food scientists also work in labs testing how different cooking methods affect the nutrition and safety of food. Some develop new ways to cook or preserve food using heat technology. Average Salary: $45,000–$55,000 per year (chefs); $65,000–$75,000 per year (food scientists)

HVAC Technician (Heating, Ventilation, and Air Conditioning)
HVAC technicians work with systems that transfer thermal energy to heat homes, schools, and buildings in winter and cool them down in summer. They understand conduction, how heat moves through air and pipes, and how to control temperature safely. When you feel warm air coming from a vent in winter, an HVAC technician designed and installed that system! They also work on refrigerators and freezers, which move heat in reverse. Average Salary: $48,000–$56,000 per year

Mechanical Engineer
Mechanical engineers design machines and systems that involve heat transfer and thermal energy—like ovens, stoves, car engines, and power plants. They use their knowledge of conduction, radiation, and how materials respond to temperature to create things that work safely and efficiently. Some mechanical engineers specifically work in the kitchen appliance industry, designing better, safer, and faster cooking equipment. Average Salary: $60,000–$90,000 per year

NGSS Connections

Performance Expectation:
5-PS3-1 Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

Disciplinary Core Ideas:
* 5-PS3.A Definitions of Energy
* 5-PS3.B Conservation of Energy and Energy Transfer

Crosscutting Concepts:
* Energy and Matter – Energy is transferred when objects interact; energy takes many forms.
* Cause and Effect – The thermal energy from the flame causes observable changes in the egg's appearance and texture.

Science Vocabulary

* Thermal Energy: The energy that comes from heat; the faster the particles in an object move, the more thermal energy it has.

* Conduction: The transfer of heat through direct contact between two objects or materials touching each other.

* Temperature: A measure of how fast the particles in an object are moving; measured in degrees.

* Irreversible Change: A change that cannot be undone or reversed (like cooking an egg); different from a reversible change like freezing water.

* Heat: The flow of thermal energy from a warmer object to a cooler object.

External Resources

Children's Books:

Heat* by Marion Dane Bauer (Let's Read and Find Out Science Series) – Explains thermal energy and heat transfer in accessible language.

What is the Sun?* by Janet Slingerland – Connects the sun as the ultimate energy source to everyday thermal phenomena.

The Magic School Bus and the Electric Field Trip* by Joanna Cole – While focused on electricity, it covers energy transfer concepts that transfer to thermal energy lessons.

Teacher Note: This lesson naturally scaffolds into discussions about energy sources (sun !' food !' cooking !' body), making it a bridge between life science and physical science standards. Encourage students to share examples of thermal energy from their homes and community!