

The Case of the Cold Cocoa

Kinetic & Potential Energy and Heat Transfer: Describe kinetic and potential energy, and investigate how thermal energy is transferred and how the amount of energy transferred depends on the type and mass of matter.

(Enrichment: this topic is not in the 2023 Indiana Grade 6 science standards.)

Learning target: I can explain how energy changes between kinetic and potential forms and identify conduction, convection, and radiation.

Success looks like: Students use the vocabulary correctly, complete the mystery case, and score 80% or higher on the evidence-based exit ticket.

Materials: Student devices, the printed lesson worksheet (one per student), projector for the mini-lesson presenter.

LESSON AT A GLANCE

60 minutes

Time	Part	Teacher does	Students do
0:00-0:08	Warm-up	Project the warm-up. Circulate, then call on 2-3 students. Save question 3 for the debrief.	Answer Part 2 of the lesson worksheet; share with a partner.
0:08-0:20	Mini-lesson	Teach with the 4-step presenter. Run each quick check with the whole class.	Complete worksheet Parts 4-11 as each slide appears; answer checks with fingers.
0:20-0:48	Mystery Case	Launch The Case of the Cold Cocoa. Assign mission levels; circulate with the answer key.	Play solo or in pairs; record code pieces; complete any written evidence task.
0:48-0:52	Debrief	Ask 2 debrief questions and revisit warm-up question 3.	Finish worksheet Part 13 (prediction check + one thing learned).
0:52-1:00	Exit ticket	Hand out the exit ticket. Collect and sort with the mastery guide.	Answer with evidence independently.

Key vocabulary

Word	Student-friendly definition
Kinetic energy	Energy of motion. More mass or more speed means more kinetic energy.
Potential energy	Stored energy. Gravitational potential energy increases with height and mass.
Conduction	Heat transfer through direct contact.
Convection	Heat transfer by the movement of fluids (liquids and gases) in currents.
Radiation	Heat transfer by waves, even through empty space.

Word	Student-friendly definition
Law of conservation of energy	Energy is not created or destroyed; it changes form.

1. WARM-UP

0:00–0:08 · 8 min

Warm-up expectations (post these): Answer in Part 2 of the lesson worksheet (or on this sheet). Number each answer to match the question. Answer in complete sentences. For math, show your work. Work silently for 5 minutes, then share with a partner for 2 minutes. Be ready to share one answer with the class.

#	Question	Look for
1	Give one example of something that has energy because it is moving.	Examples: a rolling ball, wind, a running dog.
2	Which has more stored energy: a book on the floor or the same book on a high shelf? Why?	The book on the high shelf, because it is higher, so it could fall farther.
3	Why does a metal spoon in hot cocoa get hot at the handle?	Heat moves through the metal from the hot end to the cooler end (conduction).

2. MINI-LESSON

0:08–0:20 · 12 min

Project the Lesson presenter from the room page. It runs the whole hour: target and agenda, warm-up with timer, hook vote, 4 teaching steps (key idea, interactive tool, turn and talk, check for understanding), I do / we do / you do, a work-time screen with a timer and expectations, debrief, and the exit ticket. Press N for teacher notes, T to pause the timer, and P to pick a student.

Hook (1 min): A pencil is held still above the floor. Does it have energy? Class vote: Yes / No, it is not moving / Not sure

Step 1 (3 min): Potential and kinetic energy

Teach	Potential energy is stored energy (height, stretched springs, food). Kinetic energy is the energy of motion. Heavier or faster objects have more kinetic energy.
Interactive tool	Board and notes
Students do	Label each as mostly PE or KE: a book on a shelf, a rolling ball, a stretched rubber band.
Turn and talk	A bowling ball and a tennis ball roll at the same speed. Which has more kinetic energy? Why?
Worksheet Part 5A	POTENTIAL energy is stored. KINETIC energy is the energy of motion.
Check for understanding	A roller coaster car is stopped at the top of a hill. It has mostly: Answer: (A) Potential energy

Step 2 (3 min): Energy transforms

Teach	As the coaster drops, potential energy changes into kinetic energy. The total stays the same (ignoring friction). That is conservation of energy.
Interactive tool	Simulation: Drive the coaster and watch the energy bars
Students do	Sketch the energy bars at the top and the bottom of the hill.
Turn and talk	Why does the first hill of a roller coaster have to be the tallest?
Worksheet Part 6A	As an object falls, potential energy changes into KINETIC energy. The TOTAL energy stays the same.
Check for understanding	Where is the coaster's kinetic energy greatest? Answer: (B) At the bottom of the biggest hill

Step 3 (3 min): Heat moves warm to cool

Teach	Heat always flows from warmer objects to cooler ones until they are the same temperature.
Interactive tool	Visual: Cocoa at 70 °C in a 20 °C room: which way does heat move?
Students do	Explain why a metal desk feels cold. Use the words heat and warmer.
Turn and talk	When you hold an ice cube, does cold move into your hand, or heat move out? Explain.
Worksheet Part 7A	Heat always moves from WARMER to COOLER objects.
Check for understanding	Hot cocoa (70 °C) sits in a 20 °C room. Heat moves: Answer: (C) From the cocoa to the room

Step 4 (3 min): Conduction, convection, radiation

Teach	Conduction: heat moves by touch. Convection: warm fluid (air or water) rises and cool fluid sinks, making currents. Radiation: heat travels as waves, like sunlight.
Interactive tool	Flip cards: Hand on a hot pan, Warm air rising from a heater, Sunlight warming your face
Students do	Write your own example of conduction, convection, and radiation.
Turn and talk	Why does a cooler keep drinks cold? Which type of heat transfer is it blocking?
Worksheet Part 8A	CONDUCTION is heat by touching. CONVECTION is heat by moving currents. RADIATION is heat by waves.
Check for understanding	A campfire warms your face from across the fire. This is: Answer: (B) Radiation

I do: worked example (shown one step at a time)

1. Imagine a roller coaster car on a big hill.
2. Step 1: At the top, the car is high and slow: most potential energy (PE).
3. Step 2: Halfway down, it has some PE and some kinetic energy (KE).
4. Step 3: At the bottom, it is low and fast: most KE.
5. Step 4: Energy changed form. It did not disappear (some becomes heat from friction).

What to say on every slide is in the presenter script PDF.

We do: guided practice

A skateboarder starts at the top of a ramp and rolls to the bottom. Describe the energy changes.

1. At the top, the skateboarder is high and still: mostly potential energy.
2. As they roll down, height decreases, so potential energy decreases.
3. Speed increases, so kinetic energy increases.
4. At the bottom, most potential energy has become kinetic energy. The total stays about the same (some is lost to friction as heat).

Answer: PE changes into KE

You do: independent check (2 min)

A pot of soup is heated from the bottom. The warm soup rises and the cooler soup sinks. This is: (A) Radiation (B) Insulation (C) Convection (D) Conduction

Answer: (C) Convection. Students who miss it: 3-minute reteach at the teacher table, then start the room at the Explorer level.

Misconception: "Cold moves into things." Heat moves; objects feel cold because heat leaves your hand.

Misconception: "Only moving things have energy." Stored (potential) energy counts too.

Misconception: "Radiation needs air to travel." Radiation crosses empty space, which is how sunlight reaches Earth.

3. MYSTERY CASE: THE CASE OF THE COLD COCOA

0:20–0:48 · 28 min

Launch: project the start screen, read the story aloud, and assign mission levels (Explorer = extra support, Agent = on level, Legend = challenge). Students can open Supports any time for read-aloud, bigger text, a word bank, and a scratch pad.

- Evidence files can be opened in any order. Tell students detectives always read the whole file before answering.
- Pairs can be "lead detective" and "note taker." The note taker records the code pieces as they are found.
- For the debrief, ask students which piece of evidence was most convincing and why.

Students turn in: the completion code plus their copied "turn in your work" block (Canvas Text Entry).

4. DEBRIEF

0:48–0:52 · 4 min

1. Trace the energy changes in a swing as it moves back and forth.
2. Which type of heat transfer keeps a room warm, and how?
3. Where did the energy "go" when the roller coaster stopped? (Friction -> thermal energy.)

Close the loop: return to warm-up question 3. Answer: Heat moves through the metal from the hot end to the cooler end (conduction).

5. EXIT TICKET

0:52–1:00 · 8 min

Print the exit ticket PDF (page 2 is the key and mastery guide). Every item requires evidence: Part A asks students to justify each choice, Part B asks for an explanation, and Part C applies the standard to a new situation using Claim-Evidence-Reasoning. Sort results into Mastered, Approaching, and Beginning to plan tomorrow's groups.

LESSON RESOURCES

Resource	How it fits the lesson
Warm-up worksheet (PDF)	Optional standalone warm-up (also Part 2 of the lesson worksheet), with a key.
Mini-lesson presenter	Projectable, step-by-step interactive lesson with tools and quick checks (room page).
Lesson worksheet (PDF + key)	One printable packet students complete during the whole lesson: short fill-ins and quick checks in 13 small parts that match the presenter slides.
The Case of the Cold Cocoa (.html)	The mystery case for Canvas, with differentiated levels, supports, and a turn-in.
Exit ticket (PDF + key)	Evidence-based check with a rubric and a mastery sorting guide.
PhET: Energy Skate Park (extra)	Students see potential and kinetic energy bar graphs change as a skater moves. https://phet.colorado.edu/
PBS LearningMedia (extra)	Search "conduction convection radiation" for demos. https://www.pbslearningmedia.org/
OpenSciEd (extra)	Free units on thermal energy transfer. https://www.openscienced.org/
Khan Academy: Physics (extra)	Short lessons on kinetic and potential energy. https://www.khanacademy.org/science

ANSWER KEY: THE CASE OF THE COLD COCOA

Evidence File #1: The Metal Mugs (code piece: W)

1. Why do the metal mugs feel so hot to hold? -> Metal conducts heat quickly from the cocoa to your hand
2. Sort each material. -> Good conductor: Copper, Aluminum, Steel spoon | Good insulator: Foam cup, Wooden handle, Wool mitten

Evidence File #2: The Steam (code piece: A)

1. Why does the warm air collect near the ceiling? -> Warm air is less dense, so it rises
2. How could the lodge slow down convection from the top of the cocoa? -> Put a lid on the mug
3. Which is an example of convection? -> A pot of soup circulating as it heats on the stove

Evidence File #3: The Fireplace (code piece: R)

1. How does the fireplace warm customers' faces? -> Radiation
2. Why can't conduction or convection bring the Sun's heat to Earth? -> Space is almost empty, with too few particles to carry heat
3. Look around the lodge. Tap the example of heat transfer by RADIATION. -> Tap Fireplace glow

Evidence File #4: The Window Table (code piece: M)

1. How many degrees did the metal mug by the window cool in 10 minutes? -> 32 °C
2. Why did the metal mug by the window cool faster than the one by the fireplace? -> The cold air around it is a bigger temperature difference, so heat leaves faster
3. What does the ceramic mug with a lid show? -> Insulating material and a lid slow heat loss

Evidence File #5: The Solution (code piece: S)

1. Match each problem to its type of heat transfer. -> Heat moving from cocoa through the metal mug to hands = Conduction; Warm air and steam rising off the open mug = Convection; Customers warmed by the fireplace from across the room = Radiation
2. Which changes would keep the cocoa warm longer? -> Keeps cocoa warm: Switch back to ceramic or foam mugs, Add lids, Seal drafts around the windows | Does not help: Use thinner metal mugs, Serve cocoa on the outdoor deck
3. Final check: tap the example of CONDUCTION. -> Tap Hot metal spoon
4. Case report: Why does cocoa get cold fastest in a metal mug with no lid by the window? Recommend the best fix for the lodge. -> Written response (CER). Model: I claim that metal mugs with no lid lose heat fastest, so the lodge should switch back to ceramic mugs with lids. Every mug started at 70 °C. The metal mug with no lid by the window dropped to 38 °C, a loss of 32 degrees, but the ceramic mug with a lid only dropped to 58 °C. This happens because metal is a conductor, so heat moves by conduction from the cocoa into the mug and the cold air. With no lid, warm air and steam rise away by convection. Ceramic is an insulator and the lid traps the heat, so the particles stay faster and the cocoa stays warm.

Final code: WARMS