Propane_heater_4 PS3 2

Physical Science | 5E Lesson Plan

4th Grade

Core Science Concepts

- Heat energy transfer: The glowing red elements are converting electrical energy into heat energy that radiates outward, demonstrating energy transformation and transfer.
- Light as a form of energy: The bright red/orange glow visible in the photograph shows light energy being produced and traveling from the heat source, allowing us to see the object from a distance.
- Patterns of energy emission: The repeating holes and the uniform glow demonstrate how heat and light energy are distributed across a surface in a predictable pattern.
- Evidence of energy in motion: The photograph captures energy in action—heat is bein…

Lesson Overview

- Grade Level: Fourth Grade
- Subject: Science (Physical Science)
- Time Allotment: Two 45-minute sessions (or one 90-minute block with a 10-minute break)
- NGSS Standards:
  - 4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
  - 4-PS4-2: Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

Learning Objectives

Students will be able to:
1. Explain that heat and light are forms of energy that can be transferred from one place to another.
2. Observe and describe evidence that objects give off light when they get very hot.
3. Identify light as energy that allows us to see glowing objects from a distance.
4. Predict how heat energy moves away from a source using evidence from observations.

---

1. ENGAGE

Objective: Activate curiosity about heat and light energy using the photograph as a visual anchor.

Materials:
- Projected or printed photograph of the glowing heater
- Chart paper or whiteboard
- Markers

Activity:

1. Display the photograph on a screen or as a large printed image where all students can see it clearly. Keep it displayed for the entire Engage phase.

2. Ask these specific discussion questions:

- "What do you see in this picture? What color are the objects, and why do you think they're that color?"
- "If you could touch this object with your hand (safely, far away), what do you think you would feel? Why?"
- "How do you think this object is making light? What do you think is happening inside those holes?"
- "If you were standing in front of this heater on a cold day, could you feel its energy from a few feet away? How?"

3. Prediction/Wonder Prompt: Show students a cold flashlight, then ask: "A flashlight makes light using electricity. This heater also makes light using electricity. What do you think is the difference between how a flashlight makes light and how this glowing heater makes light?" Record student predictions on chart paper without correcting.

4. Share student ideas freely. Write their responses verbatim—this activates their prior knowledge and creates investment in finding answers.

Transition: "Today we're going to become energy detectives and investigate how heat and light are connected, just like in this photograph."

---

2. EXPLORE

Objective: Students investigate heat and light energy transfer through safe, hands-on experimentation.

Materials:
- 4-5 incandescent lightbulbs (40-60 watt, NOT LED—these do not produce sufficient heat) or heat lamps with ceramic bulbs
- Socket lamps or heat lamp fixtures (pre-set up by teacher for safety)
- Small thermometers (1-2 per group, digital or analog, rated to at least 150°F)
- Ruler or meter stick
- Hand-held mirrors (1 per group)
- Safety goggles (1 per student)
- Chart paper or data recording sheets (printed or projected)
- Timer or clock

CRITICAL SAFETY NOTE: Bulbs must be powered ON before students arrive and remain in fixtures throughout exploration. Students never touch the bulbs themselves. You should test all equipment beforehand and set up in a space where students can safely work 12-18 inches away from the fixtures.

Activity:

1. Divide students into groups of 3-4. Assign each group a station with a pre-lit bulb in a fixture.

2. Distribute safety goggles and have students put them on before beginning.

3. Provide these student directions (written on a card or displayed):
   - "LOOK at your glowing bulb from the front. Describe what you see. Is it bright? What color is it?" (Record observations)
   - "HOLD your hand 12 inches away from (but not touching!) the bulb for 10 seconds. What do you feel? Is it warm, hot, or very hot?" (Record: temperature feeling)
   - "MOVE your hand closer (to about 6 inches). What changes? Does the heat feel stronger?" (Record changes)
   - "HOLD the thermometer 6 inches from the bulb for 30 seconds without touching the bulb. What temperature does it read?" (Record the temperature)
   - "USE the mirror to reflect light from the bulb onto the wall or paper. Can you see the reflected light clearly? Does the reflected light feel warm?" (Record observations about light)

- "WRITE or draw: Where is the heat coming from? Where is the light coming from?"

4. Teacher's role during exploration:
- Circulate to each group.
- Ask probing questions: "What changed when you moved closer?" "Where do you think the heat is traveling to?" "Why can you see the light even if you're not looking directly at the bulb?"
- Do NOT tell students the answer—guide them to notice patterns.
- Ensure safety (students don't get too close, goggles stay on).
- Help with thermometer reading if needed.

5. Document what students observe:
- Record temperature readings on a class chart.
- Collect drawings or notes about where heat and light come from.

Expected Student Outcomes:
- Students will observe that the bulb glows (light energy).
- Students will feel heat radiating outward from the bulb (heat energy transfer).
- Students will notice that heat is stronger closer to the source.
- Students will discover that light can be reflected and travels through space.
- Students will record evidence showing heat and light moving away from the bulb.

---

3. EXPLAIN

Objective: Formalize vocabulary and concepts after hands-on discovery.

Materials:
- Anchor chart (pre-made or created now) with vocabulary and drawings
- Colored markers
- The original photograph (still displayed)
- Simple diagram of energy transfer (create on whiteboard as you teach)

Activity:

1. Group share-out (5 minutes):
- Ask each group to share one observation: "What did you feel/see/discover?"
- Record key observations on chart paper.
- Highlight repeated findings (e.g., "heat gets stronger closer to the bulb").

2. Introduce vocabulary (8 minutes) with clear, Fourth Grade-friendly definitions:

VOCABULARY:

- Heat Energy: The energy that makes things warm. Heat always travels from hot things to cooler things. In this heater, electricity becomes heat energy.

- Light Energy: A form of energy that we can see. It travels in straight lines away from bright objects and helps us see things. In this heater, the hot wire also makes light energy.

- Energy Transfer: When energy moves from one place to another. Heat transfers away from the hot bulb. Light travels from the bright bulb to your eyes.

- Thermal Energy (or "heat energy"): The total energy of all the moving particles in something. The hotter an object is, the more thermal energy it has.

- Glow: To shine with light, usually because something is very hot. When electricity makes the metal wire very hot, it glows.

3. Make connections back to the photograph (4 minutes):
- "Look at this heater. Just like your lightbulb, the heating element inside is glowing. Why is it glowing? Because it's very hot! The holes let the heat and light escape and travel through the air to warm a room. The red color shows us the metal is extremely hot—hotter than your lightbulb."
- Point to specific parts of the photograph: "This red glow is light energy. This heat energy is traveling outward, just like you felt when you put your hand near the bulb."

4. Check for understanding (3 minutes):
- Ask: "Can you feel light? Can you see heat?" (Guide students to understand light enters eyes, but we feel heat on skin.)
- Ask: "If I turn off the heater, will the red glow stop? Why?" (The wire cools down and stops glowing.)
- Ask: "How did the electricity become heat and light?" (It passed through a special wire that resists the electricity, making it very hot.)

Expected Student Outcomes:
- Students can define heat energy and light energy in their own words.
- Students understand that both heat and light travel away from hot, glowing objects.
- Students recognize the glowing heater in the photograph as an example of heat and light energy transfer.

---

4. ELABORATE

Objective: Apply heat and light concepts to real-world scenarios and deepen understanding.

Materials:
- Images or video clip of other glowing/heating objects (oven, campfire, match, sun, glow stick, light bulb in a lamp)
- Sorting cards or a printed matching activity
- Chart paper or whiteboard
- Student response notebooks or sheets

Activity:

Option A: Real-World Energy Transfer Sorting

1. Show students 5-6 images of different heat and light sources: candle flame, oven coils, campfire, lightbulb, sun, match.

2. Ask: "Which of these transfer HEAT energy? Which transfer LIGHT energy? Which do both?"

3. Have students work in pairs or small groups to sort the images and explain their thinking:
- "Why did you put the campfire in the 'both heat and light' pile?"
- "Can you feel heat from the sun? Can you see light from the sun?"

4. Teacher role: Facilitate discussion, asking: "What do all the 'heat' objects have in common?" (They are hot. Electricity or fuel makes them very hot.)

5. Record responses on a class chart: Objects That Make Heat | Objects That Make Light | Objects That Make Both

Option B: Design a Heat/Light Transfer Scenario

1. Present this scenario: "You're camping on a cold night. You need to warm up AND see the ground in front of you. Which would work best: a flashlight, a candle, or a campfire? Why?"

2. Have students explain their choice using evidence:
   - "A campfire gives off BOTH heat energy and light energy, so it's best."
   - "A flashlight gives light but not much heat."

3. Ask: "How does the energy travel from the campfire to your body and eyes?" (Heat and light radiate outward in all directions.)

Expected Student Outcomes:
- Students identify multiple sources of heat and light energy.
- Students explain which types of energy different objects produce.
- Students apply the concept of energy transfer to real-world contexts.
- Students use evidence to support their reasoning.

---

5. EVALUATE

Objective: Assess understanding of heat and light energy transfer.

Activity:

Formative Assessment (Throughout the lesson):
- Observe student questions and comments during Engage.
- Monitor group discussions during Explore for evidence of understanding.
- Listen to explanations during Explain group share-out.
- Watch student sorting and reasoning during Elaborate.

Exit Ticket / Summative Assessment (5-7 minutes, end of Session 2):

Provide each student with a paper or digital form with these questions. Read aloud to ensure comprehension:

1. "Look at this picture of a glowing toaster oven coil. Name TWO types of energy this object is giving off."
   - Expected answer: Heat (or thermal energy) and light.

2. "Explain how the heat energy moves away from the toaster coil. Where does it go?"
   - Expected answer: The heat travels outward through the air and can reach your hands/face if you're close to it.

3. "If you were standing 3 feet away from the heater in the original picture, you could see the red glow and feel warmth. Explain how BOTH light and heat reached you from that distance."
   - Expected answer: The light energy traveled through the air to my eyes, allowing me to see the glow. The heat energy traveled through the air and warmed my body.

4. "Draw or explain: What would happen to the light and heat if you turned the heater off?"
   - Expected answer: The metal would cool down, the red glow would disappear (light stops), and the heat would stop traveling outward.

Success Criteria:
- ' Student identifies at least two types of energy (heat and light).
- ' Student explains that energy travels away from the source.
- ' Student gives evidence connecting their observation to the photograph.
- ' Student recognizes the connection between temperature and glow.

How to Determine if Students Met Learning Objectives:
- LO1 (Explain heat and light are energy): Student defines or describes both on exit ticket with 70%+ accuracy.
- LO2 (Observe evidence of heat and light): Student records observations in Explore phase and references them in Explain/Evaluate.
- LO3 (Identify light allows us to see): Student explains that light from the heater reached their eyes in question 3.
- LO4 (Predict heat movement): Student predicts changes in Elaborate and explains them on exit ticket.

Differentiation

Support (For Struggling Learners):

1. Provide sentence frames for exit ticket responses:
   - "This object gives off _____ energy and _____ energy."
   - "The heat travels _____ away from the source."
   - "When I turned it off, the glow _____ because the metal got _____."

2. Pair students with a partner during Explore to share observations and help with thermometer reading.

3. Use a visual anchor chart with pictures of heat (wavy lines or sun symbol) and light (light rays or lightning bolt symbol) to help students distinguish concepts. Point to it during explanation and when reviewing vocabulary.

4. Reduce the number of observations in Explore—focus only on "What do you feel?" and "What do you see?" Skip thermometer reading if it's too complex; simply describe "hot" vs. "warm."

Challenge (For Advanced Learners):

1. Investigate temperature differences: Have students measure temperature at different distances (6 inches, 12 inches, 18 inches) and graph the data. Ask: "Why does temperature decrease with distance? What does this tell us about how energy travels?"

2. Explain the mechanism: Provide simplified information about how electricity flows through a resistance wire, making it hot enough to glow. Ask: "Why do you think this particular wire glows instead of just warming up like a heating pad?" (It's much hotter due to high resistance.)

3. Compare energy efficiency: Show pictures of an incandescent bulb, LED bulb, and heat lamp. Ask: "Which one wastes the most energy as heat? Which one gives off the most light? Why might we choose one over another?" (This connects to real-world energy use and sustainability.)

4. Design challenge: "Design a device that transfers heat from an object 2 feet away to another location using light and/or heat. How would you do it?" (Accept answers like mirrors for light, or aluminum foil to reflect heat.)

Extension Activities

1. Glow Stick Investigation (5E follow-up):
   - Provide glow sticks (chemical light source) and compare them to the heater. Ask: "This makes light without being hot. How is this different from the heater?" Students discover light and heat can be produced separately, challenging their assumption that all light comes from hot objects. (Connects to 4-PS4-2.)

2. Home Heat and Light Hunt:
   - Assign homework: "Walk around your home and find 5 objects that give off heat, light, or both. Make a list or draw pictures. Which ones did you expect? Which surprised you?" (Refrigerator doesn't give off light but uses electricity; laptop gets warm; lampshade gets warm but light comes from bulb, etc.)

3. Infrared Investigation (if school has an infrared thermometer or thermal camera):
   - Use an infrared thermometer or thermal imaging device to show students that objects give off heat even when they're not glowing visibly. Point the device at warm (not glowing) objects like the radiator, warm hand, or insulated container. Ask: "We can't SEE the heat, but the thermometer detects it. What does this tell us about heat energy?" (Heat exists even without visible light; it travels in forms we can't always see.)

Teacher Preparation Checklist

- ' Test all incandescent bulbs and lamps before class to ensure they work safely.
- ' Set up lamp fixtures securely on a table where students can work 12-18 inches away.
- ' Check thermometers for accuracy.
- ' Print or project the photograph clearly.
- ' Print exit ticket questions or prepare digital form.
- ' Create vocabulary anchor chart (or plan to create it with students).
- ' Gather images of other heat/light sources for Elaborate phase.
- ' Prepare data collection sheets for groups.
- ' Have safety goggles ready for each student.

This lesson directly addresses NGSS 4-PS3-2 and 4-PS4-2 by providing observable evidence that energy (heat and light) transfers from place to place, and that light entering the eye allows us to see glowing objects. The photograph of the glowing heater serves as both the hook and the anchor for understanding these abstract energy concepts in a concrete, relatable way.

Differentiation

Support (For Struggling Learners):

1. Provide sentence frames for exit ticket responses:
   - "This object gives off _____ energy and _____ energy."
   - "The heat travels _____ away from the source."
   - "When I turned it off, the glow _____ because the metal got _____."

2. Pair students with a partner during Explore to share observations and help with thermometer reading.

3. Use a visual anchor chart with pictures of heat (wavy lines or sun symbol) and light (light rays or lightning bolt symbol) to help students distinguish concepts. Point to it during explanation and when reviewing vocabulary.

4. Reduce the number of observations in Explore—focus only on "What do you feel?" and "What do you see?" Skip thermometer reading if it's too complex; simply describe "hot" vs. "warm."

Challenge (For Advanced Learners):

1. Investigate temperature differences: Have students measure temperature at different distances (6 inches, 12 inches, 18 inches) and graph the data. Ask: "Why does temperature decrease with distance? What does this tell us about how energy travels?"

2. Explain the mechanism: Provide simplified information about how electricity flows through a resistance wire, making it hot enough to glow. Ask: "Why do you think this particular wire glows instead of just warming up like a heating pad?" (It's much hotter due to high resistance.)

3. Compare energy efficiency: Show pictures of an incandescent bulb, LED bulb, and heat lamp. Ask: "Which one wastes the most energy as heat? Which one gives off the most light? Why might we choose one over another?" (This connects to real-world energy use and sustainability.)

4. Design challenge: "Design a device that transfers heat from an object 2 feet away to another location using light and/or heat. How would you do it?" (Accept answers like mirrors for light, or aluminum foil to reflect heat.)

Extension Activities

1. Glow Stick Investigation (5E follow-up):
   - Provide glow sticks (chemical light source) and compare them to the heater. Ask: "This makes light without being hot. How is this different from the heater?" Students discover light and heat can be produced separately, challenging their assumption that all light comes from hot objects. (Connects to 4-PS4-2.)

2. Home Heat and Light Hunt:
   - Assign homework: "Walk around your home and find 5 objects that give off heat, light, or both. Make a list or draw pictures. Which ones did you expect? Which surprised you?" (Refrigerator doesn't give off light but uses electricity; laptop gets warm; lampshade gets warm but light comes from bulb, etc.)

3. Infrared Investigation (if school has an infrared thermometer or thermal camera):
   - Use an infrared thermometer or thermal imaging device to show students that objects give off heat even when they're not glowing visibly. Point the device at warm (not glowing) objects like the radiator, warm hand, or insulated container. Ask: "We can't SEE the heat, but the thermometer detects it. What does this tell us about heat energy?" (Heat exists even without visible light; it travels in forms we can't always see.)
