HEAT QUEST - TEACHER NOTES

investigating conduction, convection, and radiation

6.PS3.2: Use a model to gather evidence to support changes to a system can be caused by transfers of sound or thermal energy (i.e., conduction, convection, or radiation).

INQUIRY-BASED PHILOSOPHY

Inquiry-based learning is a student-centered approach where learning is driven by questions, investigations, and curiosity. Instead of memorizing information, students actively explore real-world problems, formulate their own questions, and seek answers through research and experimentation. This method encourages critical thinking, problem-solving skills, and a deeper understanding of concepts.

HEAT QUEST PREPARATION + GROUPING

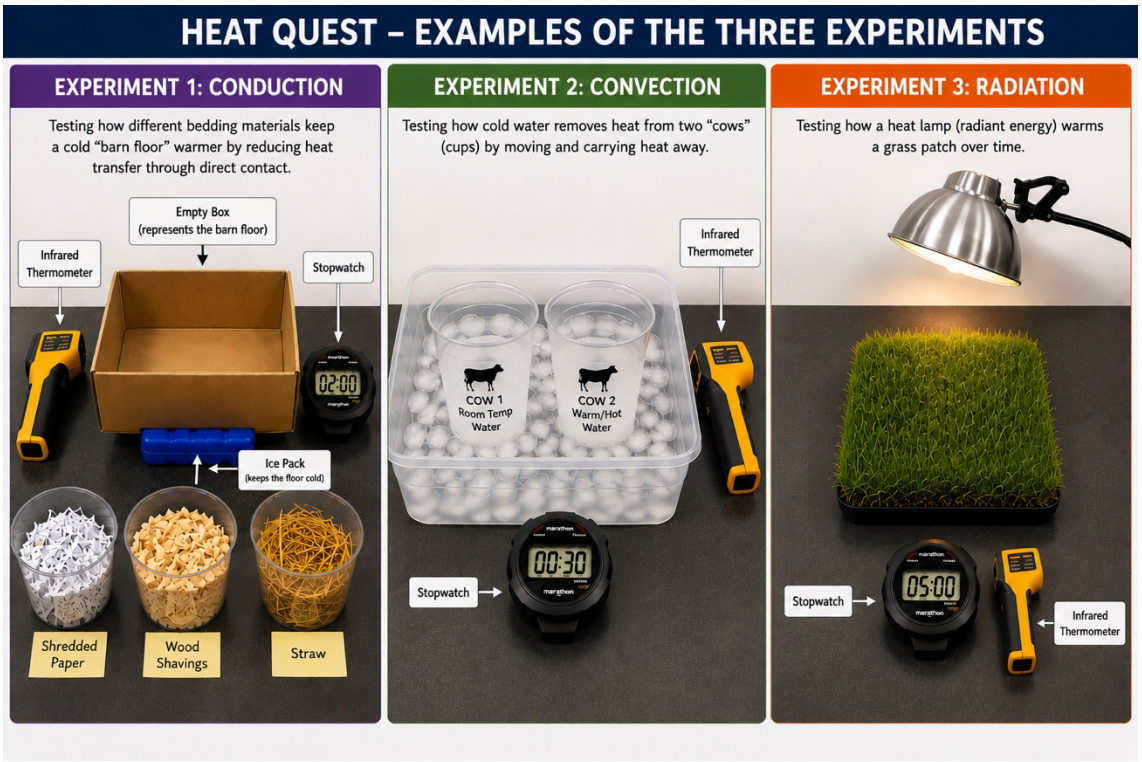
There is room to run this lab in many ways, depending on your classroom needs. Each method of heat transfer has its own experiment, so it is possible to spend multiple days covering this topic.

Options include:

A. **Divide students into groups of 4 and assign each group just one experiment.** This will require a longer debrief to allow students to explain their experiment and results to the other groups. The benefit of this method would be a swifter timeframe to cover all three methods. It also allows the students to take more ownership of "teaching" their fellow classmates about their procedures and results.

B. **Divide students into groups of 4 and have them complete each experiment.** This will likely take multiple days, having students complete one experiment per day. The benefit of this method would be focusing on one method at a time. It also allows for you to have more in-depth conversations about what variables may have contributed to the variations between the groups.

C. **Complete one or more experiment(s) together as a class, then divide into groups of 4 and divide them between the remaining experiment(s).** This may be helpful if one particular method or experiment needs to be teacher-guided.



GENERAL TIPS

- Consider running a few practice trials to demonstrate proper technique with an infrared thermometer. Remind students that it requires aiming the sensor correctly, and not to point the sensor toward anyone's eyes.
- Students often think the activity is over once they have data. Ensure students complete the Analysis as part of the experiment, so they are ready to present to the group as a whole.

EXPERIMENT 1: CONDUCTION SET-UP + TIPS

- Consider demonstrating or having an example box with shredded paper to demonstrate a properly covered bottom of the box. Ask the students if the amount of bedding, in addition to type, may have an effect.
- Teachers may provide a new box and frozen ice pack for each part of the experiment to help maintain consistent starting conditions. If materials are reused, allow the box to return close to room temperature and use a fully frozen ice pack before beginning the next trial.
- Emphasize the control and no-bedding measurements before students begin testing the bedding materials. For each temperature reading, students should hold the infrared thermometer approximately 1 inch above the center of the box or bedding material to keep measurements as consistent as possible. Keep the box on the ice pack for the full 2-minute trial and use the same amount of each bedding material so the bedding type is the primary variable being compared.
- Students will take the temperature at the end of the timed period (unlike the other experiments, where students will take temperature at 30-second intervals). Because students may have more downtime during this experiment, consider assigning a productive task, such as cleaning up used bedding materials or discussing their predictions with their group.
- Expected Learning Outcome: Students should conclude that insulating materials slow heat transfer through conduction. Bedding that traps more air generally reduces heat loss.
- Discussion Questions: Which bedding insulated best? Why? How does this apply to livestock? How might different weather conditions change which bedding is best?

EXPERIMENT 2: CONVECTION SET-UP + TIPS

- Consider how you will keep yourself and students safe with the hot water. Depending on your classroom set-up, it may be safer to deliver the hot water to each group instead of relying on them to walk it safely back to their area.
- Emphasize keeping conditions consistent between both trials. Maintain the pond water at 3 inches deep, keep each cup at the same depth, and do not allow pond water to enter the cups. Leave the frozen ice packs underneath the tub to help maintain a consistent temperature, and check that the pond water is still close to its starting temperature before beginning the Cow 2 trial.
- Guide students to compare the temperature changes of the room-temperature and hot-water cups over time. Ask students to use their data to determine which changed temperature more quickly and explain how thermal energy moved from the warmer water to the colder surroundings.
- Expected Learning Outcome: Students observe heat moving from warmer water to cooler water until temperatures become more similar.
- Discussion Questions: Which cup cooled faster? How does water help animals regulate body temperature? Why is moving water more effective at cooling than still air?

EXPERIMENT 3: RADIATION SET-UP + TIPS

- It may be helpful to have an important discussion of safety with the heat lamp. Remind students not to touch the bulb for any reason.
- Students will test one pasture condition at a time: No Shade, Foam Shade, and Cork Shade. Before each trial, students should record a new starting temperature. Starting temperatures should be as similar as possible.
- Keep the heat lamp 12 inches above the grass patch for every trial. During the Foam and Cork trials, the shade should remain 4 inches above the grass and should not be lifted, removed, or repositioned during the 5-minute trial. Students should aim the infrared thermometer underneath the shade from the side.
- Students will record temperatures every 30 seconds for 5 minutes. Remind students to measure approximately 1 inch above the same area of the farm animal each time.
- Between trials, students should use a new grass patch at room temperature or allow the current grass patch to cool close to its original temperature. The farm animal should also return close to room temperature before the next trial begins. The two grass patches are used one at a time so one can cool while the other is being used.
- Before students turn on the heat lamp, verify that the lamp is 12 inches above the grass and that all materials are safely positioned. Remind students never to touch the bulb.
- Expected Learning Outcome: Students should recognize that radiant energy can increase the temperature of an object and that shade materials can reduce exposure to radiant energy. Students should use their temperature data to compare No Shade, Foam Shade, and Cork Shade conditions.
- Discussion Questions: How did the No Shade condition compare with the shaded conditions? Which shade material reduced heating most effectively? What evidence from your data supports your conclusion? Why are shade structures important for livestock?

Before Class Checklist

- Freeze ice packs
- Prepare hot and room-temperature water
- Test infrared thermometers
- Verify heat lamps are working and can be positioned 12 inches above the grass patches.
- Prepare foam and cork shade materials
- Make sure grass patches and farm animals begin near room temperature
- Organize station materials

Assessment Suggestions

- Evidence-based predictions
- Accurate data collection
- Correct identification of heat transfer
- Data-supported conclusions
- Real-world agricultural connections

Extensions

- Have students identify examples of conduction, convection, and radiation in agriculture and everyday life and justify their examples with evidence.