

Answer Key: Thermal Energy at School

Grade: 7 **Subject:** Science **For teacher use only** Science

How to use this key

Answers are grouped by section and question number. Many items are open-ended; accept any response that shows correct reasoning even if the wording differs. Notes flag where more than one answer is defensible and list common misconceptions to watch for. Estimated grading time: ~5–7 min per packet.

Start Notice & Wonder grade for effort · ~2 min

1 Metal vs. wood at the same temperature.

Full credit for any reasonable notice + wonder. **Ideal:** Notice — "the metal feels colder than the wood." Wonder — "why do they feel different if the thermometer reads the same?" Accept any on-topic wonder. *Science note (not required from students):* metal conducts thermal energy away from the hand faster, so it feels colder even at equal temperature.

2 Two places at school that warm or cool.

Accept any two real locations with a direction. Examples: a desk by a sunny window (warms), a shaded hallway (cooler), the cafeteria after cooking (warms), a stairwell in the morning (cool). More than one answer is defensible.

Build Read the Science ~1 min

3 Which mode needs no particles + the example shown.

Radiation. Example from the diagram: the sun's rays passing through the window (sun → through window). This is the only mode that can cross empty space.

Apply Use the Data ~2 min

4 Observation (O) vs. Inference (I).

- a) **O** — a directly measured value (48 °C).
- b) **I** — it explains a cause ("because the sun heated it by radiation").
- c) **O** — a directly measured value (24 °C).
- d) **I** — a reasoned conclusion about *why* it is cooler.

Observation = measured/seen directly; inference = a conclusion reasoned from evidence.

5 Sunlit (44 °C) vs. shaded (29 °C) concrete.

The sunlit concrete absorbed **radiation** from the sun, raising its temperature; the shaded concrete received little direct sunlight. Accept any sentence naming radiation (sunlight) as the cause of the ~15 °C difference. Reject "conduction" as the primary cause here.

6 Classify each transfer.

6a — A (Conduction). The can warms by direct contact with the metal rail.

6b — B (Convection). A fan moves warm air (a gas) around the room.

6c — C (Radiation). Sunlight (rays) warms the backpack.

7 Redesign reasoning (worked example).

Award full credit if the student names a valid mode *and* explains the mechanism. Worked examples:

- **(i) Light-colored blinds:** targets **radiation**. Blinds block/reflect incoming sunlight before it enters, so less radiant energy is absorbed inside. (Strongest choice — see Q8.)
- **(ii) Fan:** targets **convection**. Moving air mixes hot air away from students and speeds cooling; it does not stop energy from entering, so it helps less than blinds.
- **(iii) Move desks to the far corner:** uses the data (far corner air = 24 °C vs. near-window 27 °C). Reasonable, but it relocates students rather than reducing the heat entering — a weaker "fix."

Any of the three earns credit if the mode + mechanism are correct. Best-reasoned answer is (i).

Explain CER (Q8) ~1–2 min

8 Which choice most reduces heat transfer into a hot classroom?

Model answer. Claim: Light-colored blinds on the window would most reduce heat transfer into the classroom.

Evidence: (1) In Table 1, sunlit surfaces were far hotter than shaded ones (sunlit concrete 44 °C vs. shaded 29 °C), showing sunlight adds a lot of energy. (2) In Figure 1, the sun's radiation enters through the window — the main path of energy into the room. **Reasoning:** Because the biggest energy input is **radiation** through the window, blocking it at the window stops the energy before it enters, unlike a fan (which only moves already-warmed air by convection).

Defensible alternates: A student may claim the fan is best if they argue convection removes built-up heat and cite Table 1's air readings; accept with sound reasoning, but the blinds argument is stronger because it addresses the source.

CER scoring rubric (3 points)

Score	Claim	Evidence	Reasoning
3	Clear, correct choice stated.	Two accurate, relevant pieces from Table 1 and/or the diagram.	Correctly links evidence to a transfer mode and explains why it reduces heat.
2	Choice stated, mostly clear.	One solid piece, or two with a minor error.	Some correct linkage but incomplete or a small misconception.
1	Vague or partly correct choice.	Evidence weak, off-topic, or not from the sources.	Little or flawed reasoning; mode not correctly named.
0	No/incorrect claim.	No evidence.	No reasoning.

Close ACE ~1 min

ACE Articulate / Connect / Extend.

Articulate: accept any accurate plain-language definition of one mode (e.g., "conduction is heat moving through touch").

Connect: the cited row/part must actually match the chosen mode (e.g., metal handrail 48 °C → conduction/radiation; heating vent → convection; sun through window → radiation).

Extend: any correct new, out-of-school example (e.g., conduction — a spoon in soup; convection — boiling water; radiation — a campfire warming your face). More than one answer is defensible.

Watch Common misconceptions

- **"Cold flows in."** Cold is not a substance. Thermal *energy* flows out of the warmer object; there is no "coldness" moving in.
- **"Heat is a material/fluid inside things."** Heat is energy transferring, not stuff stored; "thermal energy" is the particle motion energy.
- **Metal is "colder" than wood.** At the same temperature they are equal; metal only *feels* colder because it conducts energy from the hand faster (Q1).
- **Confusing convection with radiation.** If a fluid (air/water) carries the energy, it's convection; if rays cross a gap, it's radiation.
- **Observation vs. inference (Q4).** Students often mark a reasoned cause as an "observation." Any "because..." statement is usually an inference.

Teacher follow-up based on likely errors

If many students miss Q4b/Q4d, do a 5-minute sort of statements into "measured" vs. "concluded." If Q6 or Q3 reveal convection/radiation confusion, re-anchor with Figure 1 (rays vs. moving air). If CER (Q8) evidence is thin, model citing a specific Table 1 row aloud. The "cold flows in" misconception is the highest-value item to address next class.

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