Start Here · six-resource supplied-data route

These six resources form a focused sequence about thermal evidence. They are intended for middle school; related NGSS expectations span Grades 6–8. Check local course placement.

Six connected questions

Read Temperature Data Before Explaining It: read measurements, including headings, units, start, time and change. Was It a Fair Comparison?: evaluate comparison conditions: what is being compared and what must match? Which Design Is Better Supported?: support a design choice with relevant paired evidence across trials. Explain Why the Temperature Changed: explain the pattern using the sample, surroundings and net transfer. Revise a Claim When Evidence Changes: revise a particular claim: retain, narrow, change or remain uncertain. Choose, Test and Improve a Thermal Protector: choose, propose a test and improve a thermal design against criteria and constraints.

Each resource includes its own bridge. The required route needs no equipment beyond paper and pencil. Optional supports include a calculator, number line, projection, pointing, oral responses or labeled responses. The separate Cool-water investigation has materials and operational instructions; it is never required for success on paper tasks.

Read the teacher quick start and intended key before printing. Student downloads have no teacher answers. The print choices identify activity names and page references; keys are in each teacher guide.

Voluntary feedback is optional.

Vocabulary, science and representation

Criterion: required performance. Constraint: resource, size or procedure limit. Prediction: testable expectation, not outcome. Observation: supplied reading. Evidence: relevant observation selected for a question. Explanation: connect evidence to a scientific idea. Revision: reconsider a particular claim using relevant new information.

Temperature in °C is not total energy. Matter type, state and amount also matter. Warming is a rise; cooling is a fall. In passive cases, net energy transfers from warmer parts toward cooler parts. Limiting warming does not cool water; slowing transfer does not stop it. Temperature data alone do not isolate a pathway, instantaneous rate or total energy.

Match conditions for the intended question. Subtraction cannot remove confounds in mass, start or time. Comparisons of whole designs can vary multiple construction features; isolated feature claims need comparisons that separate those features. Fresh trials use fresh samples; several timed readings of one sample remain one run.

A displayed boundary pass is nominal. Unknown accuracy and trial variation limit confidence; headroom is not a reliability probability. Similar readings do not prove equality; retain contrary records. One new design result under changed conditions cannot establish a new ranking against an untested design.

Respond in connected prose, orally while pointing to data, or with a labeled representation. Clarify the question, table access, vocabulary and response mode before choosing a reteach. Sparse language can express adequate reasoning.

A labeled model, sparse connected prose or an oral account may show the same reasoning. Ask “Which values?” “Which part is warmer?” “What exact claim?” before prescribing reteaching. Record support and actual exposure. No rigid paragraph template, student label or automated diagnosis.

Print and exposure choices

The first five resources have full student tasks plus Teach the Lesson, Use a Quick Check, two focused reteaching choices and Use a Later Check. Each has a separate teacher guide with matching task headings and answer keys.

For the thermal protector challenge, choose Teach the Design Challenge, Use a Quick Check, Reteach: Meet Every Requirement, Reteach: Improve the Design and the Test, or Use a Later Check. Match each task title to the answers in the separate teacher guide.

Quick Check in every core kit reuses its independent task. It is an alternate print route, not fresh after lesson exposure. Reteach rechecks and later tasks are fresh only until shown or attempted. Record whether the learner saw a model, practiced the task, answered independently, reused a task or attempted a later check.

Revise a Claim When Evidence Changes, Choose, Test and Improve a Thermal Protector and portfolio sequences require an initial record or proposal before a separate page of new evidence. Print on one side and distribute in order; the full packet or preview does not keep the new-evidence page separate. Keep earlier records visible after the reveal. Cool-water investigation first comparisons and redesign and retest are actual distinct phases, not assumed outcomes.

Portfolio Integrative-A and Integrative-B are two fresh different contexts, not equivalent forms. Teacher example pages contain twelve explicitly fictional annotated responses. The blank teacher record keeps dimensions separate. Do not interpret score changes as learning effects.

Response → supplied next task

Measurement reading or direction unclear → Read Temperature Data Before Explaining It Compare the Measurements, Keep readings in one row, questions 1–2; endpoint and change confused → Read Temperature Data Before Explaining It Value or Change, A value is not a change, questions 1–3. Unequal comparison conditions → Was It a Fair Comparison? Repair the Comparison, Subtraction does not fix a confound, questions 1–2; incomplete plan → Was It a Fair Comparison? Specify the Plan, Specify a usable plan, questions 1–3.

One convenient trial or an “always” claim → Which Design Is Better Supported? Use All Results and Limit the Claim, Use all results and limit the claim, questions 1–3 for practice; reserve the separate New short check · Apply the correction, question 4 until practice is complete, full student pp. 6–7. Repeated readings without explanation → Explain Why the Temperature Changed Connect Evidence to the Explanation, Connect evidence to the explanation, questions 1–2; Fresh recheck · Connect a new record, question 1, pp. 6–7. Cold treated as a substance, reversed direction or stopped transfer → clarify wording, then Explain Why the Temperature Changed Trace Energy Transfer, Trace energy transfer, questions 1–2; Fresh recheck · Trace a new case, question 1, pp. 8–9.

Ignoring new inconvenient evidence → Revise a Claim When Evidence Changes Keep the Evidence, Change the Claim, Initial claim and support, question 1; Keep the evidence, change the claim, question 1; Fresh recheck · Initial record, question 1; Fresh recheck · Additional record, question 1, pp. 9–12. Pooling incomparable new records or assuming the newest wins → Revise a Claim When Evidence Changes Compare Conditions Before Revising, Initial conditions and claim, question 1; Compare conditions before revising, questions 1–2; Fresh recheck · Initial conditions, question 1; Fresh recheck · Changed surroundings, question 1, pp. 13–16. Use the initial→new reveal sequence.

Missing a design requirement or replacing every trial with a mean → Choose, Test and Improve a Thermal Protector Meet Every Requirement, Meet every requirement, questions 1–2 then Fresh recheck · What if none qualifies?, question 1, pp. 6–7. Unsupported improvement or feature attribution → Choose, Test and Improve a Thermal Protector Improve the Design and the Test, A proposal needs a relevant test, questions 1–2 then Fresh recheck · Whole design or one feature?, question 1, pp. 8–9. Correct reasoning but unclear writing → oral or labeled clarification rather than automatic science reteach.

After Independent task, choose a still unseen Later Check, not the reused Quick Check. If all checks are already shown, use them as practice and record the limitation. The portfolio examples distinguish visible evidence, unconfirmed interpretation, a clarifying prompt and the exact next task.

Cool-water investigation and actual session routes

Cool-water investigation is an optional distinct companion: cool water warms toward room temperature; construct safe sleeves, compare fresh paired trials, retain raw records, redesign and retest against an identified reference. Use its operational card, measured quantity, geometry and instrument requirements, blank forms and three selections. Follow ordinary supervision and school procedures. No tasting, hot apparatus or student cutting or puncturing.

The Cool-water investigation data fallback is complete if equipment or access is unsuitable. It supports reasoning but does not show learner construction or testing. Blank empirical records contain no invented readings. Completed fictional records are labeled constructed. Practical success is unknown until actual measurements; negligible, variable or worse results remain valid outcomes.

The Session Routes teacher guide provides six paper sessions and eight design and investigation sessions with exact task and print references, targets, demonstrations, work, collected responses and next decisions. Times are planning estimates, not observed durations. Practical repetitions may need continuation blocks; no equipment homework is required.

The six-session paper route uses all six thermal resources, including the proposal and new-evidence cycle in Choose, Test and Improve a Thermal Protector. The eight-session route uses Read Temperature Data Before Explaining It, Was It a Fair Comparison?, Which Design Is Better Supported?, a paired Explain Why the Temperature Changed and Revise the Claim When Results Change block, Choose, Test and Improve a Thermal Protector, then the cool-water investigation first test, redesign and retest. Each block has prerequisites and routing alternatives; enter through the named bridge when appropriate.

A provided protocol is not evidence that an experiment occurred.

Sources and classroom copying

Sources: NGSS MS-PS3-3 addresses thermal transfer and device design; MS-ETS1-3 addresses design criteria, constraints and evidence; MS-ETS1-4 addresses testing and improvement. NSTA Safety and School Science Instruction informs the supervision and setup guidance. These materials address selected ideas and do not represent complete standards coverage.

Paper analysis addresses selected ideas, not physical design, construction or testing, or complete expectations. The practical protocol may support more components when learners actually perform them; possession of the file is not completion. No source endorses these resources. Cases, tables and text are original; external material is paraphrased and linked, not copied. Preserve site Terms of Use and classroom copying terms.