

Teacher quick start · Kit 4

Target: connect temperature observations to a scientific explanation of net transfer, distinguish observations/models and state a limit. Prerequisites: °C/time/start/change, warming/cooling and sample/surroundings; bridge P supplies all needed instruction. Grade 6 is a provisional authoring target within the NGSS Grades 6–8 band; check local course placement. Paper and pencil only. Optional calculator, number line, pointing, projection, oral explanation or labeled diagram.

Print and teach

Teach the Lesson: Kit4-v 1.0.0-Teach-the-Lesson.pdf, student pp 1–5 (P/M/V/G/I). Teacher pp 2–5. Use a Quick Check: Kit4-v 1.0.0-Use-a-Quick-Check.pdf, I, student p 5; teacher p 5. I is the same independent task in the lesson, not fresh afterward.

Reteach: Connect Evidence to the Explanation: Kit4-v 1.0.0-Reteach-Connect-Evidence-to-the-Explanation.pdf, A/Ac, student pp 6–7; teacher p 6. Reteach: Trace Energy Transfer: Kit4-v 1.0.0-Reteach-Trace-Energy-Transfer.pdf, B/Bc, student pp 8–9; teacher p 7. Use a Later Check: Kit4-v 1.0.0-Use-a-Later-Check.pdf, T/E, student pp 10–11; teacher p 8. Each selection contains its own setup/data.

Sequence and response route

Author estimates, not classroom timings: P8 min → M/V10 min → G8 min → I10 min, about 36–45 min; reteach 10–15 min; later 8–12 min. Model M/V, prompt G, then collect I without its key. Keep teacher files separate.

Repeats readings without connection → A/Ac. Reversed arrow, cold-as-substance or stopped-transfer idea → B/Bc, after clarifying intended meaning. Correct arrow without data → A. Accept accurate connected prose, a labeled representation, or an oral explanation pointing to data. First ask the learner to point to the row, restate the question and explain aloud. Record response mode and support. An unclear or blank response is insufficient evidence of a science difficulty; clarify reading, language and access before choosing a reteach.

All data constructed. No apparatus, scoring or uploads. Sources/partial standards p 9; print map/exposure p 10. If I was seen, use new T/E later. Human science review and classroom feedback are separate from AI review.

P · Teach the prerequisite bridge

K4-D-P · 100 g water; 23°C surroundings; 10 min

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Sample	Start (°C)	After 10 min (°C)
H	13	17

Say: “H13°C at start is an observation. I select 13 → 17°C because our question asks whether it warmed: that is evidence. I add an explanation: the surroundings are warmer than H, so net thermal-energy transfer is toward the water. That scientific idea connects the evidence; it is not another thermometer reading. The sample is water; surroundings include cup/lid/support/room.”

K4-P1: Water H; 23°C surroundings; 13°C sample start, 10 min, 13 → 17°C = 4°C warming. Surroundings include cup/lid/support/room, not only the air.

K4-P2: (a) observation; (b) evidence selected to support warming; (c) scientific idea explaining direction in this stated case. Evidence is selected observations, not a separate type of measurement. An explanation must connect(c) to 13 → 17°C, not merely name a law.

Readiness: ask for a point to start/final/unit/time and identification of the warmer part. If subtraction alone is difficult, use a number line/calculator. If observation versus explanation is unclear, sort the three statements aloud and ask what the idea adds. If direction remains reversed, teach B before I. Do not require the earlier kits; this bridge teaches needed ideas.

M/V · Complete teacher model

K4-D-M · 100 g water; 24°C surroundings; one 15 min run

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Elapsed time (min)	Water (°C)
0	12
5	14
10	16
15	17

Think aloud: “12 → 17°C is 5°C warming. The incomplete answer accurately reports this but does not explain it. I identify the water as our sample and 24°C surroundings as warmer. Net thermal-energy transfer is toward cooler water; that is consistent with warming. I draw a boundary around water and an arrow inward. The arrow uses a scientific idea; the table did not measure it.”

Defensible model: “The water warmed from 12°C to 17°C in 15 minutes. In this passive setup, 24°C surroundings are warmer, so net thermal-energy transfer is toward the water. This accounts for the rise; the record does not identify each pathway or document an actual experiment.”

Equivalent model description: outer region room/cup/lid/support 24°C; inner water 100 g, 12 → 17°C; arrow surroundings → water labeled net thermal-energy transfer. The original representation is on student V; these labels describe its full content.

K4-M1: All quoted values and 5°C warming describe supplied observations; they do not connect to the warmer surroundings and transfer direction.

K4-M2: Water rose 12 → 17°C over 15 min. 24°C surroundings are warmer throughout. Net thermal-energy transfer is toward the cooler water, consistent with warming. This is a science-informed explanation of a constructed pattern; it does not prove a unique pathway, actual product performance or an instantaneous rate. Accept any scientifically adequate connection and specific limit.

K4-M3: Table observations: time/readings and their calculated 5°C rise. The representation adds a boundary and net-transfer arrow using a scientific model. The thermometer did not measure the arrow or the separate pathways; conduction alone is not established.

Draw only the net arrow; do not imply particles cross the boundary or that temperature measures total stored energy. Repeated time readings of this one sample are not independent trials.

G · Cooling practice and actual teaching moves

K4-D-G · 100 g water; 21°C surroundings; one 15 min run

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Elapsed time (min)	Water (°C)
0	37
5	34
10	32
15	30

Ask: “Which two readings matter? Name the warmer part. Where should a net-transfer arrow start/end? How does that help explain the change?” If “cold entered,” ask the learner to point to warmer/cooler and trace the arrow; then refine wording. If “lower is better,” return to the question: explain the change, not select a design.

K4-G1: 37 → 30°C from 0 → 15 min is 7°C cooling. Accept e.g. 37°C at 0 min and 32°C at 10 min with a 5°C fall for that stated interval, or additional accurate readings. The full-interval answer is 7°C.

K4-G2: Water is warmer than 21°C surroundings throughout; net thermal-energy transfer is from water toward surroundings, consistent with its falling temperature. Accept outward arrow with labels/readings or an oral account. Cold is not a transferred substance.

K4-G3: We explain why temperature changed; there is no comparison design or performance criterion. Lower temperature alone does not establish a better sleeve. No ranking, unique mechanism, total-energy amount or real experiment is established.

Anticipated answer “37 → 30°C because it cooled”: accurate description, missing connection; request surrounding temperature and direction. “Energy leaves”: ask which sample, why that direction, and which readings support cooling. Accept a correct outward labeled arrow with data. If the idea is correct but writing is difficult, collect an oral response and note support.

I · Independent key and routing

K4-D-I · fresh 80 g each; 20°C surroundings; 12 min; matched independent trials

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Trial ID	Start (°C)	After 12 min (°C)
I-1	31	27
I-2	31	26
I-3	31	27

K4-I1: 31 → 27°C is 4°C cooling in I-1/I-3; 31 → 26°C is 5°C cooling in I-2. All cool across 12 min. Use two or all three trials. Do not invent a cause for I-2's difference.

K4-I2: Sample: 80 g water; surroundings 20°C; water 31°C initially and 26–27°C finally, all warmer than surroundings. Net energy transfer is outward, consistent with cooling. Specific initial/final readings and the cooler surroundings must connect; naming transfer without connecting to data is incomplete.

K4-I3: Accept unmeasured pathways, other intervals/conditions, unknown accuracy or invented data's lack of actual physical evidence, with a matching next step. Example: pathway contributions need measurements designed to separate them, not these endpoints. Observed (supplied): time/temperatures. Model: net arrow and scientific direction. No instantaneous rate or total-energy calculation required.

Look separately for selected evidence, sample/surroundings, scientifically consistent direction/connection and a meaningful limit. No rigid sentence count or CER boxes. Correct 4/5°C calculations alone do not show explanation. Ask "How does the surroundings' temperature help explain it?" before reteach.

If only readings appear, choose A/Ac. If the arrow remains inward for this case or speaker insists cold is a transferred substance, choose B/Bc after clarification. A mismatch between a correct oral account and written response indicates an expression/access need. Do not use Quick Check I as unseen after the lesson.

A · Connect evidence to the explanation

K4-D-A · 100 g water; 26°C surroundings; one 10 min run

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Elapsed time (min)	Water (°C)
0	15
5	18
10	20

Think aloud: “Response 1 supplies 15 → 20°C but no reason. Response 2 has a scientific rule but no link to this case. I join them: water warms 5°C while 26°C surroundings are warmer; net transfer toward water accounts for the rise. I can use a data-labeled arrow, not a prescribed paragraph.” Ask learner to supply A2, keeping the two incomplete responses visible.

K4-A1: Response 1 supplies readings but no scientific connection; response 2 supplies a general idea without identifying the specific warmer/cooler parts or evidence. Both can be improved; do not treat a correct generic idea as wholly wrong.

K4-A2: 15 → 20°C over 10 min gives 5°C warming; 26°C surroundings warmer than water; net energy transfers toward water, consistent with rise. Thermometer record does not measure individual pathways. Accept a labeled arrow linked to readings without prose.

K4-D-Ac · fresh 90 g water; 23°C surroundings; 8 min

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Sample	Start (°C)	After 8 min (°C)
R	35	31

K4-A3: 35 → 31°C over 8 min is 4°C cooling; water warmer than 23°C surroundings; net transfer outward. Accept a meaningful pathway/other-condition/constructed-data limit. This fresh cooling case checks the connection, not paragraph fluency.

Recheck A3 has not been modeled; withhold it until practice is complete. An adequate connection shows use on this task, not mastery. If evidence accurate but direction reversed, use B. If arrow correct without values, prompt one specific reading and explain its relevance.

B · Trace energy transfer

K4-D-B · matched 100 g; 22°C surroundings; 15 min

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Setup	Start (°C)	After 15 min (°C)
No sleeve	10	18
Sleeve V	10	14

Intervention: “Point to 10°C water and 22°C surroundings. Which is warmer? Show the net arrow.” Then trace V10 → 14°C. “It warmed, so in this passive case transfer did not stop. It warmed less than no sleeve, which is a different statement from cooling.” Ask the learner what “cold entered” means before labeling the idea. Use their arrow/data account to distinguish loose wording from a reversed model.

K4-B1: Ask “Which part is warmer? Show where your arrow begins and ends. Do you mean the water changed temperature, or cold is a substance?” 10 → 14°C shows V warmed 4°C; no sleeve warms 8°C. If speaker gives correct outward/inward direction and uses colloquial cold, refine language without automatically assigning conceptual reteach. A repeated reversed arrow or claim of no transfer despite warming indicates a conceptual issue.

K4-B2: V10 → 14°C warms 4°C; 22°C surroundings warmer. Net transfer inward; V limits warming relative to no sleeve 10 → 18°C, but does not lower its start or stop transfer. Equal water masses and phase allow smaller rise to be consistent with less net energy entering over this interval. No unique pathway or proven material property.

K4-D-Bc · fresh 100 g sleeved water; 21°C surroundings; 10 min

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Sample	Start (°C)	After 10 min (°C)
Sleeved W	33	29

K4-B3: 33 → 29°C is 4°C cooling; 21°C surroundings cooler; net transfer outward. Sleeve did not make cold or stop the net transfer indicated by cooling in this passive case. No unsleeved comparator, so no quantified sleeve effect; any specific-condition or mechanism limit acceptable.

Fresh B3 reverses direction; do not draw its arrow first. If correct after support, record that support. Unknown pathway, no control and constructed data remain useful limits.

T · Later key and interpretation

K4-D-T · 60 g water; 19°C surroundings; one 12 min run

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Elapsed time (min)	Liquid water (°C)
0	9
6	12
12	14

K4-T1: 9 → 14°C over 12 min is 5°C warming (12°C at 6 min also valid evidence). 19°C surroundings warmer; net transfer inward. Chamber context changes, science connection persists. No pathway partition, instantaneous rate or actual experiment follows.

K4-D-E · idealized uniform 22°C, not measured equilibrium

Constructed teaching data: these values were invented for this activity, not collected in an experiment.

Idealized case	Water (°C)	All surroundings (°C)
Uniform temperatures throughout	22	22

K4-T2: Given uniform equal temperatures and the exclusions, no net thermal-energy transfer driven by a temperature difference. Particles of 22°C liquid water continue moving; microscopic exchange can occur with no net transfer. Equal temperature does not mean no particle motion or equal total energy in unlike amounts/types of matter.

K4-T3: One unchanged reading does not prove equilibrium. Need surrounding and sample temperatures (including uniformity), time evidence, measurement accuracy/resolution and absence of other inputs/outputs or balancing processes. Accept a coherent subset with explanation of why. A reading may hide a small change or reflect balanced transfers.

A successful response shows explanation in this changed setting and distinction between no net transfer and particle motion. It does not prove durable mastery, equal difficulty with I, actual investigation skill or instrument competence. T/E must remain unseen until later. Clarify access/meaning before choosing A or B.

Science, sources and partial standards

A temperature reading is not total energy. Type, state and amount of matter also affect total energy. For these passive, single-phase cases, net thermal-energy transfer is from warmer parts toward cooler parts. An arrow represents that net transfer, not a substance called cold or an individual particle path. Temperature readings alone do not isolate conduction, convection or radiation, calculate total transferred energy, or show an instantaneous transfer rate. Limiting warming is not cooling; limiting transfer is not stopping it.

Kit 4 P/M/G//A/B/T connect evidence with a net-transfer model: selected PS3.B ideas from MS-PS3-3, and the evidence/explanation and temperature distinctions in MS-PS3-4. These tasks neither construct/test a device nor conduct an investigation or cover the whole expectations. E adds a conceptual equilibrium distinction, not a complete standards assessment.

OpenStax College Physics 2 e 13.1 and 13.4 support equilibrium/no net transfer and continued thermal particle motion at nonzero temperature: <https://openstax.org/books/college-physics-2e/pages/13-1-temperature> and <https://openstax.org/books/college-physics-2e/pages/13-4-kinetic-theory-atomic-and-molecular-explanation-of-pressure-and-temperature>. Teacher background only; no formulas or total-energy calculations required.

Official sources checked 2026-09-29: NGSS MS-PS3-3 (<https://www.nextgenscience.org/pe/ms-ps3-3-energy>) and MS-PS3-4 (<https://www.nextgenscience.org/pe/ms-ps3-4-energy>); NSTA revision connection (<https://my.nsta.org/ngss/NSforSEP.aspx?id=3>). These support specific ideas, not validation or complete standards coverage. All text/data/representations are original; external sources are paraphrased and linked, not reproduced. Classroom copying/adaptation follows <https://mentorteaching.com/terms-of-use/>.

Review limitations are resource-specific. Independent AI review is not human science review or classroom validation. No practical procedure, real product inference, instrument accuracy or measured learning outcome is supplied. All timings are author estimates.

Print references and task exposure

Student full packet: P1,M2,V3,G4,I5,A6,Ac 7,B8,Bc 9,T10,E11. Teacher sections: QS1,P2,M/V3,G4,I5,A/Ac 6,B/Bc 7,T/E8,S9,X10. The same source creates full files and each selection; page numbering in a selection restarts at 1.

Teach the Lesson: selection pp 1–5=P/M/V/G/I; teacher pp 2–5. Quick Check: selection p 1=I; teacher p 5.

Connect Evidence reteach: selection pp 1–2=A/Ac; teacher p 6. Trace Energy reteach: selection pp 1–2=B/Bc; teacher p 7. Later Check: selection pp 1–2=T/E; teacher p 8. Exact filenames are on QS.

Exposure: P supported bridge; M/V modeled; G guided practice; I initially independent, reused by Quick Check; A/B intervention/practice; Ac/Bc fresh short rechecks until shown; T/E fresh later transfer until shown. All K4 datasets are newly authored, not foundation records with new labels. Full exposure map across Kits 1–5 is supplied separately and summarized in Start Here v 1.1.0.

Do not distribute all student pages before independent/later responses if freshness matters. Print the selected route. Oral/diagram support may be provided while keeping the scientific demand; record actual task exposure/support rather than a mastery score.