

Quick start · Two finished session routes

Print SessionRoutes-v1.0.0-Teacher-Guide.pdf; use the exact student selections listed on each page. All sessions need the matching kit teacher key and quick start, kept separate. The supplied full Kits 1–6 classroom archive holds the original kits and new guide; the optional P1 archive has its own materials and forms. No mandatory student internet access.

Author estimates only. The six-session paper route may use continuation blocks, particularly for Kits 5 and 6. The eight-session practical route includes three first comparisons and three redesign comparisons with fresh water. If the class period is 45 min, split at the specified continuation point; do not eliminate repeats or assign equipment homework.

Collect representative responses, not scores. Check prerequisites, support access, then choose an exact follow-up. Quick Check reuses I. Actual task and page selections are verified by the task manifest; no resource is empty or missing a teacher-supplied example.

Paper session 1 · Read measurements

Target / author estimate

Read measurements; 35–45 min.

Print / prior evidence

Kit 1 Teach-the-Lesson, student pp. 1–5; K1-P1/P2, M1–M3, V1/V2, G1–G3, I1–I3.

Read small tables and subtract; bridge P checks this.

Teacher demonstration

Trace one row: initial, final, time and direction, using M. Show equivalent graph V without requiring plotting.

Learner work / collect

Guided G, then independent I. Collect starting values, change, direction and observation.

Next decision / continuation

If values are reversed or mixed: K1-A1/A2; if final and change are confused: K1-B1–B3 before the next session.

Paper session 2 · Evaluate conditions

Target / author estimate

Evaluate conditions; 35–45 min.

Print / prior evidence

Kit 2 Teach-the-Lesson, student pp. 1–4; K2-P1/P2, M1–M3, G1–G3, I1–I3.

Evidence of headings and change from session 1; use K2 P if entering directly.

Teacher demonstration

Identify the intended comparison and relevant conditions for mass, start, time, cup, room and readout in M.

Learner work / collect

Critique G, repair the plan, then independent I. Collect named confounds and a matched recording plan.

Next decision / continuation

K2-A1/A2 for confounds; K2-B1–B3 for recording details before trial comparison.

Paper session 3 · Support a design choice

Target / author estimate

Support a design choice; 36–44 min.

Print / prior evidence

Kit 3 Teach-the-Lesson, student pp. 1–4; legacy P1–P4/M1–M5/G1–G3/I1–I5, qualified kit3/... .

Comparable conditions and temperature change; bridge P supplies a check.

Teacher demonstration

Use M for a matched comparison and bounded claim; do not show independent I in the model.

Learner work / collect

G, then unseen I. Collect comparisons across trials and one useful limit.

Next decision / continuation

kit3/F1–F4 if selecting only favorable evidence or saying “always”; R1–R3 if reading is difficult; fresh T1–T3 later, not Quick Check.

Paper session 4 · Explain the pattern

Target / author estimate

Explain the pattern; 36–45 min.

Print / prior evidence

Kit 4 Teach-the-Lesson, student pp. 1–5; K4-P1/P2, M1/M2/M3, G1–G3, I1–I3.

Read changes and distinguish observations; bridge P checks the scientific connection.

Teacher demonstration

Use the M/V explanatory model of warm water in a room and its equivalent text. Contrast cooling in G.

Learner work / collect

Guided cooling, then independent I; collect values, direction, idea and limit.

Next decision / continuation

K4-A1–A3 if only readings are given; K4-B1–B3 for net direction, cold or stopping transfer; clarify wording first.

Paper session 5 · Revise a particular claim

Target / author estimate

Revise a particular claim; 45–55 min.

Print / prior evidence

Kit 5 Teach-the-Lesson, student pp. 1–8; P1/P2, M1–M3, MR1–MR7, G1–G3, I1–I3 (all K5-prefixed).

A bounded claim and a scientific connection. Bridge P names the claim, evidence and conditions.

Teacher demonstration

Use M0 for the original claim, then reveal M1; complete the seven MR fields.

Learner work / collect

Reveal G0 → G1 and I0 → I1 after original responses. Collect the original claim, new conditions, decision, reason and next evidence.

Next decision / continuation

K5-A1–A4 for ignoring records; B1–B5 for comparability or assuming the newest wins. Extend to a second block if 55 min is needed.

Paper session 6 · Complete the paper design cycle

Target / author estimate

Complete the paper design cycle; 55–70 min or two blocks.

Print / prior evidence

Kit 6 Teach-the-Design-Challenge, student pp. 1–5; K6-P1/P2, M1/M2, G1/G2, I1–I4.

Feasible criteria and constraints, and revision. P supplies a standalone bridge.

Teacher demonstration

In M, check all trials, budget and thickness, and state a priority; guide G tradeoffs.

Learner work / collect

I0: proposal and test; then a separate I1 reassessment of fictional redesigns. Collect feasibility, hypothesis, test and revised claim.

Next decision / continuation

K6-A1/A2 then A3; B1/B2 then B3; later T1–T3 if unseen. Break after G for continuation, not homework.

Practical route session 1 · Read and compare quantities

Target: Read and compare quantities. Author estimate: 35–45 min.

Print / prior evidence

Use the exact Kit 1 print selections and tasks from Paper session 1; collect change and direction.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

Bridge P, then $M \rightarrow G \rightarrow I$.

Next decision / continuation

Use K1-A/B as needed; carry checked start and time reading into the next session.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.

Practical route session 2 · Plan a comparable investigation

Target: Plan a comparable investigation. Author estimate: 35–45 min.

Print / prior evidence

Use the exact Kit 2 print selections and tasks from Paper session 2; collect a matched plan.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

K2 $M \rightarrow G \rightarrow I$; emphasize physical conditions in relation to the question.

Next decision / continuation

Complete follow-up on confounds and the recording plan before planning apparatus.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.

Practical route session 3 · Use representative trial evidence

Target: Use representative trial evidence. Author estimate: 36–44 min.

Print / prior evidence

Use the exact Kit 3 print selections and tasks from Paper session 3; collect a bounded comparison.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

M → G → I; distinguish time points from fresh trials.

Next decision / continuation

kit3/F or R if needed; choose a fresh later check, not I again.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.

Practical route session 4 · Explain and revise

Target: Explain and revise. Author estimate: 60–75 min, or two blocks.

Print / prior evidence

Kit 4 bridge P, model M/V, cooling G, independent I (pp. 1–5); Kit 5 bridge P and G0 → G1 (pp. 1, 5–6, K5-P1/P2, G1–G3). Matching keys: K4 P–I, K5 P/G.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

Explain net transfer, then retain a bounded claim when new comparable results remain consistent. Collect a scientific connection and a reason for revision.

Next decision / continuation

If needed, continue after Kit 4 I before the Kit 5 bridge and guided case; use K4 A/B or K5 A/B. Do not count guided K5 G as independent.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.

Practical route session 5 · Design against requirements

Target: Design against requirements. Author estimate: 55–70 min or two blocks.

Print / prior evidence

Use the exact Kit 6 print selections and tasks from Paper session 6; complete the full proposal → reveal cycle.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

Check every requirement, choose a priority, propose a matched test and reassess fictional redesigns.

Next decision / continuation

K6 A/B as needed; prepare the P1 teacher operational card and instruments before the next session.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.

Practical route session 6 · Assemble and run first comparison

Target: Assemble and run first comparison. Author estimate: 65–80 min plus teacher preparation.

Print / prior evidence

P1 Prepare-and-Run-the-First-Comparison selection: P1-B1/B2, P1-P1, P1-C1–C3; P1-F1-SET/LOG, P1-F2-SET/LOG, P1-F3-SET/LOG, P1-A1–A3. Full student pp1–9 and 13; optional fallback CASE1 p15. Teacher operational pp1–6 and keys pp8–12.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

The teacher checks container, lid, probe, water and setup readiness; model recording with the fictional completed record, not invented student results. Learners assemble a prototype, run three fresh paired trials at 0/5/10 min, and retain starts, conditions and departures.

Next decision / continuation

Collect three complete records from the first phase and the construction version. If the period is 45 min, stop after trial 1, then drain, clean and store dry labeled sleeves; continue fresh trials 2 and 3 in the next block before redesign. Never make up readings.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.

Practical route session 7 · Redesign and begin retest

Target: Redesign and begin retest. Author estimate: 45–60 min plus continuation as needed.

Print / prior evidence

P1 Redesign-and-Retest selection: reference P1 versus redesign P2. P1-R-PLAN/R-REF (full p14), R1–R3-SET/-LOG (pp10–12), A4/A5 (p17); CASE2 (p16) only for fallback. Teacher operational pp2–6 and keys pp12–16.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

Analyze all first records; state the prediction, modification and constraints. The teacher confirms safe assembly and a matched question. Assemble, record the version and perform the first fresh paired trial of the old reference and redesign.

Next decision / continuation

Collect the design log, prediction and first retest record. If the first phase is incomplete, continue it first; retain 3 fresh pairs per phase. Do not replace unknown results with fallback values.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.

Practical route session 8 · Finish retest and explain limits

Target: Finish retest and explain limits. Author estimate: 50–65 min; add a continuation block if measurement or cleanup causes delays.

Print / prior evidence

P1 Redesign-and-Retest records 2/3 (P1-R2/R3-SET/-LOG, full pp11–12), then Compare-the-Results-and-Reflect (P1-A4/A5, E1–E3, full pp17–18); teacher keys pp15–17. Withhold separate Use-a-Later-Reasoning-Check (P1-L1, full p19) for a still-unseen check.

Prerequisites: preceding collected evidence or the corresponding standalone kit bridge. The P1 operational setup must be fully checked before handling.

Demonstration / learner work / collect

Run the remaining two fresh pairs (0/5/10 min), compare all retests with the identified reference, and account for drift, mismatch or missing data; use the supplied fallback if equipment is unavailable.

Next decision / continuation

Collect all raw records, a bounded result, revision and next test; clean up. Worse, negligible or variable outcomes are legitimate. Keep notes about actual physical work separate from the paper fallback.

No equipment homework or mandatory student internet access. Use the complete P1 fallback for learners who do not handle equipment or when equipment is unsuitable; record that the fallback does not show construction or testing.