

The Graph That Looks Like a Hill

Teacher Notes — run it cold in 40 minutes

Motion Foundations · Lab Activity 1 · ConceptArc Education (FundaFirst HS) · fundafirsths.com

What you need: floor tape or chalk marks 0–8 m along the front (a metre-ish stride is fine), a steady clap or metronome app, the activity file open (projector or shared link — it works offline once loaded, nothing to install, no accounts), and one worksheet per student. **The one rule:** every prediction goes down in ink before any reveal. A changed answer beside a crossed-out one is the artefact you want.

Run of show — 40 minutes

0–5	Lay the tape. Declare +x aloud and write it on the board. Recruit one walker, two spotters.
5–15	The walk (no screens). Walker does 2 m → 7 m → 4 m while you clap seconds; spotters call crossings; the class fills the event table on the worksheet. Then worksheet 1(a)–(d). Do not accept “5 m” for displacement silently — ask <i>initial value, final value, did she pass any point twice?</i> For 1(d), wait for the numerical guesses (“0.1 s”) before the contrast question.
15–23	Scene 2 (projected). Type the class’s own table in. Candidates appear: students commit in ink, then vote; tap the tally. Reveal. Ask: <i>up where? Up in what direction?</i> Re-run the replay while pointing at the flat track. Round 2 with the steady walk.
23–31	Scene 3. Two volunteers drive Level 1, then Level 2 (ask: <i>the track is straight — what is the curve telling us?</i>). Present Level 3 as a normal challenge; let two attempts fail; then “Why can no one match this?” and worksheet 3(b).
31–36	Scene 4. Play to the freeze at $t = 4$ s. Commit Q1 and Q2 in ink; tally; Reveal. To the “same speed” voters, the next question is <i>why?</i> — “because they’re together” said aloud is the misconception surfacing. Show the slope triangles.
36–40	Worksheet Part 4 completion lines; Layer B for 11–12. Homework hook: send the file/link — Scene 5 (Builder) challenge 1: <i>go right, stop, return — then pin a claim that conflicts with your own model, and resolve it.</i> Layer C is for the students who ask for more.

Running short? Cut Scene 4 — and defer Worksheet Part 4 with it (both open next lesson); spend the final minutes on the Part 2–3 completion lines instead. Never cut the ink-commit step. Individual-device rooms: students run Scenes 1–3 self-paced (~25 min), then you run Scene 4 together.

The three scripts, in lesson order — plus one standing rule

Script 1 — Position vs distance (the walk): Draw the number line. An object goes 2 → 7 → 4 m. Ask: *displacement?* Do not accept “5 m”. Then ask: *what’s the difference between displacement and distance travelled?* Let a student answer in their own words before you correct.

Script 2 — The arch (Scene 2): Many will say “goes up to 7 m and comes back down.” The lesson is the next question: *up where? Up in what direction?* The walk stayed on the level floor. The arch is in the graph, not in the world.

Script 3 — Alongside (Scene 4): Two objects, alongside at one instant. Ask: *same speed at that instant?* When students say yes, ask *why?* “Because they’re alongside” is the misconception, named aloud. Same position at one instant is one fact; same speed is a different fact — read velocity from each line’s slope (speed is its size).

Standing rule — language guard (whole lesson): keep to *position, clock reading, event, interval*. When a pupil claims the walker is there “for a tiny moment”, return to worksheet 1(d): an instant is one clock reading, with zero duration.

Fit with the FundaFirst HS toolkit

- This activity is the classroom form of the E1 → E4 → E7 remediation block: run it when the class heatmap flags *x–t graph meaning* and/or *position-speed discrimination* — or before the diagnostic as a foundations lesson; the numbers here deliberately differ from the diagnostic’s items.
- If your class has already sat the diagnostic, the matching worksheet sections (E1, E4, E7 of the Motion Foundations Remediation Worksheet) extend this lesson item-by-item; the traps by name are in the Mistake Museum (#4, #7).
- After the lesson, the class’s Round-1 tally is worth keeping: which candidate drew the votes tells you which misreading your class favours — the picture-of-the-path, the teleport, or the distance graph (the line that never comes back down).

Why this lesson exists (provenance)

Graph-as-picture and position-speed confusion are extensively documented misconception families in kinematics: Trowbridge & McDermott, *Am. J. Phys.* 48, 1020 (1980); McDermott, Rosenquist & van Zee, *Am. J. Phys.* 55 (1987); Beichner, *Am. J. Phys.* 62, 750 (1994); real-time graphing gains in Thornton & Sokoloff, *Am. J. Phys.* 58, 858 (1990); teaching moves after Arons, *A Guide to Introductory Physics Teaching*, Ch. 2. The commit-before-reveal protocol follows the Interactive Lecture Demonstration tradition; interactive motion↔graph tools go back to Trowbridge’s *Graphs & Tracks* and PhET’s *Moving Man*; step-level checking of student work goes back to the Andes physics tutor (VanLehn et al., *Int. J. Artificial Intelligence in Education* 15, 2005). What is FundaFirst-specific: the candidates and reveals are wired to the same misconception bands as your class heatmap, so the lesson and the report speak one language. These difficulties are documented at high rates even in selective, calculus-based university cohorts (Trowbridge & McDermott 1980; McDermott, Rosenquist & van Zee 1987) — foundations precision is not remedial content.