

## Fair-testing forces: design your own

### Lesson at a glance

Open with a playground-slide hook: how do engineers decide a safe slope? Teacher demos one fair car-and-ramp roll, revealing Change, Measure and Average live on the board. Groups pick their own force question (weight, ramp height or floor surface), sort cards on the fair-test-planner interactive, then complete their Investigation Journal page. They run three trials per version, average distances in centimetres, and pool results on the data-recorder bar chart. Close with a display-only talk on why fair testing makes engineering decisions trustworthy.

### Learning objectives

- Pose a testable force question and plan a fair test to answer it
- Run repeats, take an average and record results carefully
- Explain why fair testing makes engineering decisions more trustworthy

### Before the bell – prep

Day before: one toy car, board or stiff-card ramp, metre stick and stacking books per group; coins or modelling clay for weight tests; carpet scraps or card for surface questions. Mark 1–2 m floor run-outs around the room edge. If space is tight, plan a two-wave rotation. Keep all kit out of sight until planning is finished.

**Materials**

| Item                                                             | Qty | Per   | Source             | Low-cost substitute                                                               |
|------------------------------------------------------------------|-----|-------|--------------------|-----------------------------------------------------------------------------------|
| toy car                                                          | 1   | group | school kit         | a marble or small ball rolled in a short length of cardboard tube track           |
| stiff card or wooden board ramp (about 40–60 cm)                 | 1   | group | classroom          | a large hardback book or a firm folder                                            |
| same-size books for stacking ramp height                         | 6   | group | classroom          | wooden blocks or sturdy boxes of equal thickness                                  |
| metre stick or measuring tape                                    | 1   | group | school kit         | a 30 cm ruler used end to end with a tally of lengths                             |
| 1 cent coins or small pieces of modelling clay for adding weight | 10  | group | classroom          | metal washers, paperclips bundled with tape, or Blu Tack lumps of similar size    |
| surface samples (carpet square, card, smooth tray)               | 1   | group | classroom          | a folded jumper, a sheet of rough sandpaper, and the bare floor as three surfaces |
| chalk or masking tape for a start line                           | 1   | group | classroom          | a pencil line on paper fixed to the floor with Blu Tack                           |
| Investigation Journal pages                                      | 1   | pupil | provided printable | ruled paper with teacher-drawn table headings copied from the board               |

**Safety watch-point**

Roll cars away from feet and faces; keep floor run-outs clear of chairs and bags. No standing on chairs for taller ramps — stack books on the floor or desk only.

### Teaching moves

- **Getting Started:** Hold up only a toy car and short board ramp — do not lay out stations yet. Ask what a playground designer must keep the same to test whether a steeper slide is faster. Collect two or three ideas and link to Irish playground, road and wheelchair-ramp engineers who rely on repeated evidence, not one guess.
- **What makes a force test fair?:** Perform the live demo, not a reading: wonder aloud, predict, raise the ramp from two books to four, release gently twice and call out distances. Reveal Change, Measure and Average as you act each one. Leave the board average  $(80 + 84 + 76 = 240; \div 3 = 80 \text{ cm})$  visible — steps 5 and 6 depend on it.
- **Choose your force question:** Visit groups fast. Push vague ideas into testable ones: “Which is better?” becomes “Does adding three coins change how far the car rolls?” Demand a plain force reason (push, pull, gravity, friction) for every prediction. Same questions across groups are fine for later comparison.
- **Plan your fair test:** Open the fair-test-planner interactive on the heavier-car model. Target sort: Change = weight; Measure = distance rolled; Keep the same = ramp height, starting point, floor surface. Then each group writes its own planner on the Investigation Journal page. Look for one change only and a no-push release.
- **Run and repeat your force test:** Hand out kit only when paths are clear. State the class measure rule once: bottom edge of ramp to front of car, in cm. Cap most groups at two versions  $\times$  three trials. Walk the room stopping anyone who changes two things or pushes the car. Use the wave rotation if floor space will not fit every run-out.
- **Record trials and averages:** Paper averages first using the board example; only then type two or three groups’ results yourself into the data-recorder interactive. Cluster same-question groups on the bar chart. Ask which bar is tallest, whether the average matched the prediction, and which trial was the odd one out.
- **What does the evidence show?:** Revoice toward evidence language: “The average was higher when... so the evidence suggests...” Draw out why Irish playground and road engineers run fair tests. End with a quick pair share on one improvement next time — more trials, clearer start line, or one change only — then move straight to tidy.

### What it should show

Steeper ramps usually send the car further. Heavier cars often roll a similar distance, sometimes a little further or less — friction and how the coins or clay are stuck both matter. Smooth floors beat carpet. A surprising result usually means the car was pushed, two variables changed at once, or measuring points differed; re-run from a still start at the marked line.



### Misconceptions & interventions

- **“We’ll make the car heavier and raise the ramp — that’ll show more.”** — Stop the set-up and ask which single question they are really answering. Point back to the planner: only one card in Change, everything else stays put.
- **Pupils push the car down the ramp instead of releasing it from rest.** — Model fingers-off at the start line once more. Any pushed trial does not count — rerun from a still start so every release matches.
- **“Our first roll was enough — we already know the answer.”** — Point at the board average example. One trial can be a fluke; three trials and an average protect the result engineers would trust.



### Differentiation

| Emerging                                                                                                                                                                                                                                                                                                                                 | Developing                                                                                                                                                                                                                                                                                           | Proficient                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Use the modelled heavier-car question with only two versions (0 coins and 3 coins); assign the pupil as official measurer and recorder reading the metre stick.</li><li>• Stay at the teacher table for the first release so the no-push start is locked in before independent trials.</li></ul> | <ul style="list-style-type: none"><li>• Run the standard two-version, three-trial design and finish the average on the Investigation Journal page using the board example.</li><li>• After recording, name one trial that was the odd one out and say whether it changed the average much.</li></ul> | <ul style="list-style-type: none"><li>• Add a third version of the variable (for example 0, 3 and 6 coins) if floor space allows, or refine how the stop point on the car is judged.</li><li>• Critique another group’s fairness aloud: what would have made their test unfair, and one change that would strengthen the evidence.</li></ul> |



### Cross-curricular hook

Tie to Maths Data and Measures — pupils average three trial distances and read the tallest bar and odd-one-out on the class chart.