energy-forces

Fair-testing forces: design your own

Lesson at a glance

Hook with a playground slide that is too steep or too gentle and ask how engineers decide what is safe. Model a fair ramp test live, revealing Change, Measure and Average one beat at a time, then groups choose their own force question about rolling cars. They sort variables on the fair-test-planner interactive, complete a paper FairTestPlanner, run three trials per version and record averages on the DataTable. Close with a class bar chart and 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

Print FairTestPlanner and DataTable pages. Gather one board/card ramp, toy car, metre stick, books, coins or clay, and optional carpet/card scraps per group. Clear 1–2 m floor run-outs; plan a two-wave layout if space is tight. Pre-open the fair-test-planner and data-recorder on the IWB.

Lesson 17

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	classroom	ruled paper with teacher-drawn table headings copied from the board

Safety watch-point

Roll cars away from feet and faces; keep run-outs clear of chair legs. 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. Ask what a playground designer must keep the same to test a steeper slide. Collect two or three ideas; link to Irish playground, road and wheelchair-ramp engineers who trust repeated evidence. Keep apparatus packed and save the phrase fair test for the next step.
- **What makes a force test fair?:** Put the unfair-test question first, then keep the fair-test sentence on screen. Live-demo one clear roll at low height and one at high height, revealing Change then Measure. Leave the board average micro-script visible (80 + 84 + 76 = 240; 240 ÷ 3 = 80 cm) — steps 5 and 6 rely on it. Head off pushing the car or changing two things at once.
- **Choose your force question:** Let each group pick its own testable force question within the rolling-car theme. Visit quickly and turn vague ideas into measurable ones (e.g. "Does adding three coins change how far it rolls?"). Ask every group to say why using push, pull, gravity or friction in plain words.
- **Plan your fair test:** Drive the fair-test-planner interactive with the heavier-car model: Change = weight; Measure = distance rolled; Keep same = ramp height, starting point, floor surface. If a card is misplaced, ask whether the answer could still be trusted. Then groups complete their own paper FairTestPlanner for their question — look for one Change, a measurable result, three Keep-the-sames, and a no-push release.
- **Run and repeat your force test:** Hand out kit only when stations and paths are clear. State the class measure rule once: bottom edge of ramp to front of car on the floor (cm). Point back to the board average example before anyone rolls. Walk the room stopping double-changes and pushes; cap most groups at two versions × three trials. Use the wave model if run-outs will not fit — both waves still get a full trial block.
- **Record trials and averages:** Quick paper check of DataTable averages first — point stuck groups at the board example for 30 seconds, then move on. You type call-outs into the data-recorder; pupils have no devices. Cluster similar questions on the chart; do not pool unlike force questions into one false class average. Ask which bar is tallest and which trial was the odd one out.
- **What does the evidence show?:** Display-only science talk. Revoice toward "the average was higher when… so the evidence suggests…". Draw out why engineers run fair tests instead of one try. If same-question groups disagree, ask what differed in method. End with a verbal pair share on one improvement next time, then tidy.

What it should show

Steeper ramps usually send the car further when release, car and floor stay the same. Heavier cars may roll a similar distance, a little further, or a little less — friction and how the weight is fixed both matter; treat the averages as the evidence. Odd long rolls usually mean a push or a changed start line; rerun from a still release. A trial that hits furniture does not count.

Lesson 17

Misconceptions & interventions

- **Pupils change the car weight and the ramp height together, or push the car instead of releasing it.** — Stop the group and ask which single question they are really answering. Model fingers-off at the start line and have them name the one Change on their planner before the next trial.
- **"Our first roll was enough — we already know the answer."** — Point at the three trial columns and the board average example. One roll can be a fluke; repeats and an average protect the result engineers would trust.
- **Pupils measure from different points (start line, middle of car, end of ramp) so distances cannot be compared.** — Restate the class rule once: bottom edge of the ramp to the front of the car on the floor, in cm. Have the group remeasure the last trial together.

Differentiation

Emerging	Developing	Proficient
• Use the modelled heavier-car question with only two versions (0 and 3 coins); teacher table checks Change / Measure / Keep-the-same before the first roll. • Assign crouch-averse pupils as official measurers and DataTable recorders.	• Prompt a force reason in plain words after the averages (push, pull, gravity, friction). • Ask which trial was the odd one out and whether rerunning it would change the average.	• Add a third version of the variable (e.g. 0, 3 and 6 coins) where floor space allows, or refine how the stop point on the car is judged. • Critique another group's method: what would have made their test unfair, and one change to strengthen the evidence.

Cross-curricular hook

Tie to Maths Data and Measures — pupils average three trial distances in cm and read the tallest bar on the class chart.