energy-forces

Simple machines: levers and ramps

Lesson at a glance

Open by asking whether pupils would rather lift a heavy box straight up or roll it up a long slope. Model a see-saw lever with a ruler, pencil pivot and bag of coins, naming effort and load aloud without sliding the pivot. Groups build their own lever, then fair-test three pivot positions and jot easiest/hardest before clearing for the ramp. They compare a straight lift with a ramp push to the same height, then try a steeper and a gentler angle. Recording lands on the Investigation Journal page: easiest setups plus one sentence on the longer-path bargain.

Learning objectives

- Build a lever and a ramp and use each to move a load
- Describe how levers and ramps let you move a load with a smaller push, if you push further or travel a longer path

Before the bell — prep

Per group the day before: one 30 cm ruler, one pencil or thick eraser as pivot, one small load (bag of coins, washers or 100 g mass), and a stiff board (hardback cover, ring-binder or thick card). Sticky tack helps seat a sliding pivot. Classroom books already in the room stack as the raised surface — nothing to cut overnight.

Lesson 18

Materials

Item	Qty	Per	Source	Low-cost substitute
30 cm ruler or stiff card strip	1	group	classroom	a sturdy wooden paint-stirrer or a flat stick from a hardware shop
pencil, triangular block or thick eraser (pivot)	1	group	classroom	a marker pen or a rolled piece of card taped into a firm tube
small load (cloth bag of coins, metal washers or 100 g mass)	1	group	school kit	a small sealed bag of rice or a filled film canister / mini food tin
plank or stiff board for ramp (about 40–60 cm)	1	group	classroom	a sturdy cardboard folder or a shelf offcut
classroom books or blocks (to raise one end of the plank and set platform height)	6	group	classroom	stacked copy books already on desks, or a desk edge as the raised surface
sticky tack (optional, to seat the pivot)	1	group	classroom	a shallow groove between two books to cradle the pivot
scrap of card or small tray so the load can slide on the ramp	1	group	classroom	a plastic lid from a tub
Investigation Journal page	1	pupil	provided printable	plain A4 paper with the same recording prompts written on the board

Safety watch-point

Fingers out from under a raised load; lower gently, never flick. One person holds the plank steady. Mind toes if a load slides off; do not stand heavy loads on desk edges.

Teaching moves

- **Getting Started:** Keep the five minutes light and apparatus out of sight. Hands up: lift straight up, or roll up a slope? Take two or three reasons, then move on with: engineers design simple machines so people can move heavy things with less effort.
- **Levers and ramps: the big idea:** Hang lever and ramp on the everyday question first, then label effort and load live at your model. Wonder–predict–test–observe–think with one weight then two, same pivot throughout. Do not slide the pivot at the front — that discovery belongs to the groups. Name the trade-off: nothing is free; a smaller force needs a longer push.
- **Build a lever:** Circulate for a stable pivot and a load that sits without rolling. If the ruler slides, seat the pivot in sticky tack or a shallow groove of two books. Key questions: Which end is the load? Where is your pivot? Which end will you push?
- **Investigate: where should the pivot go?:** Say the fair-test reminder aloud: change only pivot position; same load, ruler and hand. After all three trials and before any kit is moved, stop the class to jot easiest pivot, hardest pivot and one note about hand travel while the lever is still built. If every position feels the same, the load is too light — add coins.
- **Build and test a ramp:** Clear lever kit aside. Do not let groups fuss over the stack — if slow, set their raised surface yourself in under a minute. Sequence is fixed: straight lift versus ramp first, then one steeper and one gentler angle to the same height. Cue: if it sticks, use a card tray so they feel the slope, not friction. Do not say 'height' when you mean steepness.
- **Record what we found:** Finish the Investigation Journal page in class from the jots. Capture lever easiest/hardest, lift-versus-ramp, steeper-versus-gentler, and one plain sentence: easier push but longer path. Sentence starter if needed: The load felt easiest to move when... because... If a group missed the ramp, run a quick whole-class demo at the front so every page still hears both halves.
- **Make sense and tidy:** Take three quick shares and revoice with effort/load language. Check the objectives: can they point to their lever and ramp and say how each helped with a smaller push over a longer path? Pack loads first, then boards and rulers; count rulers back in.

What it should show

Pivot closer to the load: push feels easier, hand travels further. Pivot nearer the hand: push feels harder, shorter path. Ramp needs less push than a straight lift to the same height, with a longer path; a gentler ramp feels easier still. If every lever position feels the same, the load is too light. If the ramp feels no easier, friction is biting — add a card tray under the load.

Lesson 18

Misconceptions & interventions

- **Pupils say machines 'give free force' — a smaller push with nothing traded away.** — Name the trade-off every time at the model and during shares: you give a longer push or a longer path for a smaller force. Nothing is free.
- **Pupils claim 'the ramp makes the load lighter.'** — Revoice: the load's weight stays the same; the ramp spreads the work over a longer distance. Have them compare the straight-lift feel with the ramp path side by side.
- **Pupils slide the pivot and change the load between trials, so the fair test collapses.** — Stop and re-voice: we change only the pivot position; same load, same ruler, same hand. Re-run the three places from a fixed setup.

Differentiation

Emerging	Developing	Proficient
• Pre-place a sticker pivot mark at the centre of the ruler as a starting point only, and set the raised surface yourself so the group still reaches lift-versus-ramp. • Offer the sentence starter: The load felt easiest to move when... because...	• Stabilise the load with a small piece of tape so it does not slide during lever trials. • After the three fixed pivot places, ask why the easier push made the hand travel further.	• Critique another group's fair test: did load, ruler and hand stay the same? • On the shared demo, predict easier or harder before the push and justify with effort/load language.

Cross-curricular hook

Link to PE and the school see-saw or wheelchair ramp at the door — pupils spot effort and load on real Irish playground and access slopes.