

## Simple machines do work: levers and pulleys

### Lesson at a glance

Open by holding up a heavy bag and asking how to get it onto a high shelf without a struggle. Model the inquiry cycle with a fixed-pivot lever and two loads, then groups build a ruler-and-pencil lever at tables and rotate to 2–3 shared cotton-reel pulley stations. They agree an oral claim on effort, distance and direction, record it on the Investigation Journal page, and watch the simple-machines interactive confirm the trade-off before linking to Dublin Port cranes and old mill machinery.

### Learning objectives

- Build and test a lever and a pulley and describe how each changes the size or direction of a force
- Explain the trade-off that when effort falls, distance rises
- Link simple machines to everyday school examples and to cranes, lifts and old mills in Ireland

### Before the bell: prep

Set up 2–3 pulley stations before the bell: metre stick secured across two stable chair backs, with a cotton reel (or a roll of sticky tape) on a pencil hung from it in a loop of string. Gather one ruler and pencil pivot plus a light load (cubes bag, half-full bottle or few books) per group. Keep apparatus off desks until after the hook.

**Materials**

| Item                                                                                     | Qty | Per                              | Source             | Low-cost substitute                                                                      |
|------------------------------------------------------------------------------------------|-----|----------------------------------|--------------------|------------------------------------------------------------------------------------------|
| 30 cm ruler or equal card strips                                                         | 1   | group                            | classroom          | a stiff strip of cardboard from a cereal box                                             |
| pencil or dowel to use as a lever pivot                                                  | 1   | group                            | classroom          | a marker pen or thick crayon laid on its side                                            |
| cotton reel or small pulley wheel                                                        | 1   | station (2–3 stations per class) | school kit         | a roll of sticky tape or masking tape slid onto a pencil, or a smooth empty thread spool |
| string or strong twine (about 1.5 m)                                                     | 1   | station (2–3 stations per class) | classroom          | thin rope or thick wool doubled up                                                       |
| metre stick                                                                              | 1   | station (2–3 stations per class) | classroom          | a long straight broom handle or a sturdy cardboard tube laid across two chair backs      |
| two stable chairs for hanging the metre stick                                            | 2   | station (2–3 stations per class) | classroom          | two desks of equal height with a gap between                                             |
| small load (cloth bag with multilink cubes, or light plastic bottle less than half full) | 1   | group                            | classroom          | a small soft-cover book tied with string                                                 |
| Investigation Journal page                                                               | 1   | pupil                            | provided printable | plain paper with the teacher prompting what to record                                    |

**Safety watch-point**

Light loads only. Secure metre sticks so they cannot roll. Nobody stands under a hanging load or climbs chairs. Keep string ends short so they cannot loop round necks.



### Teaching moves

- **What is a lever?:** Project only simple machine and lever. Model wonder–predict–test–observe–think live with a ruler on a fixed pencil pivot: one book, then two, same pivot and finger place. Write the five inquiry words up. Do not slide the pivot at the front: save that discovery for groups.
- **Build a lever, then try a pulley:** Reveal lever lines first and call stop-and-try. Visit tables asking which pivot felt easiest. Only then name pulley and rotate groups to stations for 2–3 minutes while others keep comparing pivots. Expect many to say pulley effort feels similar: affirm that the win is pulling down to lift up.
- **Compare and agree your claim:** No rebuild: fair-test comparison only. Prompt: same load, same person judging effort, change only pivot place or hand-lift versus pulley. Circulate with What stayed the same? If effort fell, what did you give up? Capture strong spoken claims to revoice before journal writing.
- **Record on your Investigation Journal page:** Tell them what to note (load, what changed, effort feel, distance or direction) rather than walking box by box. Put both sentence stems on the board so groups whose pulley effort stayed the same are not forced into a trade-off sentence.
- **Effort and distance side by side:** Drive the simple-machines interactive yourself on the IWB. Hands-up predict before each change. On lever, slide pivot toward the load and ask what you give up when pushing gets easier. Switch to one pulley and dwell: direction change, effort often similar. Link back to what fingers and string felt.
- **What did we learn?:** Take three or four voices. Revoice: lever trades effort for distance; a single fixed pulley is still a simple machine when it only changes direction. Name Dublin Port cranes, warehouse lifts and historic mill machinery. Pack away: lower loads first, untie string, check floors.

### What it should show

Lever: pivot nearer the load gives an easier push but longer hand travel; pivot nearer the middle feels harder with a shorter press. Single fixed pulley: effort often similar to a direct lift; the clear change is direction: pull down to lift up. A group whose lever feels unchanged usually left the pivot in the same place; re-run with a clear slide toward the load.



### Misconceptions & interventions

- **Simple machines give free energy: the job just gets easier with nothing traded away.** Ask: when the lever push felt lighter, what happened to how far your hand moved? Have them re-press with the pivot near the load and watch the long travel, then name the trade-off.
- **A pulley always makes the lift feel lighter, like the lever did.** Have them lift the same load by hand, then on the single fixed pulley. Affirm similar effort is correct; the win is pulling down instead of up: safer and easier to control.
- **The pivot should stay in the middle because that is how a see-saw works.** Point at their two trials: show the middle pivot needed a harder press. Ask which place made the heavy end lift with the lightest finger push.



### Differentiation

| Emerging                                                                                                                                                                                                                       | Developing                                                                                                                                                                                                 | Proficient                                                                                                                                                                                                                                                                                                                                                |
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| <ul style="list-style-type: none"><li>• Work at the teacher table with a pre-set pencil pivot and two marked pivot spots already on the ruler; use spoken stems: The lever felt easier when... The pulley changed...</li></ul> | <ul style="list-style-type: none"><li>• Add a third lever pivot position between middle and near-load, or re-run the pulley comparing hand-lift and pull while a partner watches direction only.</li></ul> | <ul style="list-style-type: none"><li>• Ask whether a machine that only changes direction is still useful, and why a crane operator might want to pull down rather than lift up, then add that reason to their journal sentence. If a gear kit is in the room, they can also turn a big gear against a small one and describe the same bargain.</li></ul> |



### Cross-curricular hook

Link to Maths measures: pupils compare hand-travel distance on the long versus short lever arm in rough ruler lengths.