

## Pulleys and gears

### Lesson at a glance

Open with a heavy bag of books and ask whether pupils would rather lift it by hand or pull a rope over a wheel above it. Name load, effort and pulley, then groups hang a single pulley from a metre stick across two chair backs and lift a light bag by pulling down. They compare that lift with a hand lift of the same load, then pack the rigs and mesh two or three gear wheels to watch direction and speed change. Three short notes go on the Investigation Journal page before a display-only class talk.

### Learning objectives

- Rig a single pulley and compare effort with and without it
- Explore how linked gears or wheels turn and change direction or speed
- Explain that a single pulley mainly changes the direction of effort, and that linked gears can change direction or speed

### Before the bell – prep

Before the bell: pair chairs with space between groups, check each metre stick sits firm across two backs, and pre-cut 1.5 m lift strings plus 30–40 cm hanging loops. Pre-thread cotton-reel substitutes on short pencils if proper pulleys are short. Stage one front rig already stable. Have light loads and 2–3 gear wheels (or notched card / rubber-banded lids) ready per group.

**Materials**

| Item                                                                    | Qty | Per   | Source     | Low-cost substitute                                                                    |
|-------------------------------------------------------------------------|-----|-------|------------|----------------------------------------------------------------------------------------|
| metre stick                                                             | 1   | group | school kit | a strong broom handle or wooden dowel long enough to span two chair backs              |
| sturdy classroom chairs                                                 | 2   | group | classroom  | two low tables of equal height if chairs are unstable                                  |
| pulley wheel                                                            | 1   | group | school kit | cotton reel on a short pencil or skewer, hung in a string stirrup from the metre stick |
| short hanging string or cable ties (to hang the pulley from the stick)  | 2   | group | classroom  | strong twine or a soft cable tie                                                       |
| short pencil or wooden skewer (only if using a cotton-reel pulley)      | 1   | group | classroom  | a blunt cocktail stick is too weak; use a full pencil or thick skewer                  |
| string (about 1.5 m lengths for the lift line)                          | 1   | group | classroom  | strong twine or thin rope                                                              |
| light load (small bag of books or kit weights)                          | 1   | group | classroom  | a small bag of sand or a water bottle half full                                        |
| plastic gear wheels (set of at least 2–3 per group) or linked wheel set | 1   | group | school kit | construction-kit gears, or 2–3 bottle lids linked with rubber bands                    |
| Investigation Journal page                                              | 1   | pupil | classroom  | plain paper ruled into a simple experiment record                                      |

**Safety watch-point**

No standing on chairs to hang gear. Keep heads and fingers out from under hanging loads; stop any swinging of weights. Clear trip hazards when packing sticks and string before gears.

### Teaching moves

- **How pulleys and gears help:** Project only the short board text. Point at the bag as the load and the hand-pull as the effort, then name the pulley as the grooved wheel a rope runs over. Flag that a single fixed pulley mainly changes direction — park any “it makes it lighter” claim for the test. Leave full gear talk until the gear step.
- **Rig the pulley:** Do not start modelling until chairs are paired, loops cut and one front rig is stable. Run the under-3-minute I-wonder cycle live: hang, thread, attach light bag, pull down slowly. Send groups to build for about 10 minutes. Circulate for tipping sticks and wheels balanced on top of the stick — re-show the hanging-loop method. Keep loads light; one adult helps any slipping stick.
- **Compare the effort:** Name the fair comparison aloud: same bag, same slow lift, only the method changes. Groups choose how they will judge “easier to control” and which one-sentence claim they will defend. Ask which way felt steadier, whether the pull direction changed, and what would make the comparison unfair. Steer talk to direction and control, not “half as heavy”.
- **Watch the gears turn:** Stop lifts, lower every load, coil strings, lift sticks off chairs two pupils at a time, clear the floor (~2 min), then hand out gear sets at tables. Keep gears flat and meshed with gentle hub pressure. Fold the class in: watchers predict before a volunteer turns the front pair. Look for opposite turns, a third gear matching the first, and slower turn on a larger driven gear. Product is one spoken notice only.
- **Record what we found:** Keep the Investigation Journal lean: which lift felt easier to control and how they judged it, how pull direction changed, and one gear observation. Offer the stem “When we used the pulley, I noticed... so I think...”. If time is tight, start the three notes in class; fast finishers add a tiny labelled sketch on the same page.
- **Make sense together:** Lead a display-only science talk. Revoice: single pulley changes effort direction; linked gears reverse direction and size can change speed; both are simple machines for useful jobs. Connect to a building-site crane, the school flagpole rope and bicycle gears. Each group shares one defended sentence.

### What it should show

Pulling down on the single fixed pulley should raise the bag — direction of effort reverses. Many pupils find the down-pull steadier to control, but the load is not truly half as heavy. Two meshed gears turn opposite ways; a third matches the first; a larger gear driven by a smaller one turns more slowly. Odd pulley results usually mean an unstable stick, a pushed rather than pulled string, or different loads between trials.



### Misconceptions & interventions

- **“The pulley makes the bag lighter” — pupils treat a single fixed pulley like a force-halving multi-pulley system.** — Accept that pulling down can feel easier to control, then revoice: same load, only the direction of effort changed. Point at the rope path over the wheel while they pull down and watch the bag rise.
- **“Gears only make things go faster.”** — Have them turn two equal gears and name the reverse direction first. If sizes differ, count turns of the small driver versus the large driven gear so they see speed can drop as well as rise.
- **Pupils balance the pulley wheel on top of the metre stick instead of hanging it freely below.** — Stop the group and re-model the short hanging loop over the stick through the pulley hook (or cotton-reel stirrup) so the groove hangs free under the stick.



### Differentiation

| Emerging                                                                                                                                                                                                                                                                                            | Developing                                                                                                                                                                                                                                                           | Proficient                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Lighter load and cotton-reel pulley if the proper wheel is fiddly; teacher table models the hanging loop once more beside them.</li><li>• Offer the journal stem “When we used the pulley, I noticed... so I think...” for the three short notes.</li></ul> | <ul style="list-style-type: none"><li>• Group chooses its own evidence for “easier to control” (steadier lift, less wobble, easier stop halfway) and defends one clear sentence.</li><li>• Add a third gear and say whether it matches gear A’s direction.</li></ul> | <ul style="list-style-type: none"><li>• If the rig is rock solid, try a slightly heavier load and critique what would make the hand-vs-pulley comparison unfair.</li><li>• Tiny labelled sketch of the pulley rig or gear train on the same Investigation Journal page; link opposite gear turn to a bike.</li></ul> |



### Cross-curricular hook

Link to everyday Irish machines — school flagpole rope, building-site crane, bicycle gears — and to Maths turns and direction language.