

Push and pull: ties and struts

Lesson at a glance

Open by holding up string and a lolly stick and asking which can push and which can only pull. Groups test both on a light book, then build a simple A-frame from two sticks and a string cross-bar and feel the forces under a gentle finger press. They record on the Investigation Journal what each material can do and which parts of their frame are the tie and the struts, then spot the same roles on picture cards of a crane, cable-stayed bridge and tent.

Learning objectives

- Identify parts of a structure that are being stretched (ties) and squashed (struts)
- Build a simple A-frame and explain what the string and sticks are doing under load

Before the bell: prep

Pre-build one demo A-frame from the kit. Print the crane, cable-stayed bridge and tent picture cards from the lesson's cut-out sheet (one set per group, or show them on the IWB). Bag string, two lolly sticks and tape or split pins per group; clear a flat desk space each. A light book per group for the push-pull tests.

Materials

Item	Qty	Per	Source	Low-cost substitute
lolly sticks	4	group	supermarket	thin dowel pieces or sturdy drinking straws
string	1	group	classroom	wool or thin garden twine
masking tape or split pins	1	group	classroom	sticky tape
demo A-frame (pre-built)	1	class	classroom	build one quickly at the start of the build step while groups watch
structure picture cards (crane, cable-stayed bridge, tent)	1	group	provided printable	show the three pictures on the IWB for the whole class
light book or small soft object for the push-pull feel test	1	group	classroom	an empty pencil case

**Safety watch-point**

One gentle finger press only on the A-frame top: no stacked books or heavy loads. Supervise split pins; collect string offcuts and pins at tidy-up.

**Teaching moves**

- **Getting Started:** Hold up one length of string and one lolly stick. Take two or three quick hands-up guesses on which can push and which can only pull. Do not demonstrate yet. Save the reveal for the group tests.
- **Ties and struts:** Name tie, strut and A-frame only; keep it short. Hold the stretch/squash definitions back until pupils have pressed their own frame in the build step: the words land once they have felt the forces.
- **Push or pull?:** Model one full cycle aloud in about two minutes: wonder, predict, push then pull the book with string, observe floppy vs tight, conclude string can only pull. Repeat with the stick. Circulate asking what happened when they tried to push with the string, and pull in watchers with 'Do you agree?'
- **Build an A-frame:** Show the pre-built demo at the front desk and write stretch/squash on the board now. Guide: overlap sticks at the top, fix with tape or pin, open the legs, tie string across the base, stand it, one gentle finger on the top join. Voice 'string is the tie, sticks are the struts' as they work. If string stays loose, open the base; if it collapses sideways, retape the top.
- **Record your findings:** Give about seven minutes while the feel is fresh. Check each Investigation Journal page has three things: what string and stick can do, which material can only be a tie, and which parts of their A-frame were tie and struts with how they could tell. Point at the frame still on the desk if anyone is stuck.
- **Find ties and struts:** Model Card A (crane) whole-class: cables above are ties, solid jib is a strut. Link back to string and stick. Groups then try the bridge and tent cards. Cold-call: 'On the crane, what is the cable doing? What is the solid arm doing?' Optionally anchor to goalposts or campsite guy-ropes.

What it should show

Every group should conclude string only pulls (floppy when pushed, tight when pulled) and a stick can push and pull. On a standing A-frame under a gentle finger press, the bottom string goes tight (tie) and the two sticks press down and out (struts). Loose string usually means legs too close or press too light; sideways collapse means a loose top join.

Misconceptions & interventions

- **Any thin part is a tie: ‘the stick is thin so it must be a tie too.’** Name the force, not the look: ‘A tie is stretched under load.’ Have them press the frame again and feel which part goes tight versus which stays stiff and pushes.
- **String can push if you hold it tightly enough.** Rewatch the book test: string goes floppy under a push and only works when pulled. Link: that is why it can only ever be a tie.
- **Heavier loads make the A-frame ‘work better’ so they stack books on top.** Stop and restate: one gentle finger is enough to feel stretch and squash; heavier loads just break the frames.

Differentiation

Emerging	Developing	Proficient
• Pair at the teacher table with the pre-built demo frame; teacher holds the top join while the pupil feels the string go tight and names tie/strut aloud before writing. • Offer a two-word desk note cue (pull only / push and pull) during the push-pull tests so the journal step is not a memory blank.	• After recording, ask ‘how could you tell?’ for one more part on their own frame before moving to the picture cards. • On Card B or C, prompt them to justify one label by linking back to the string or stick test.	• Challenge: explain why a crane puts cables above the jib and a stiff arm below, using tie and strut language. • Spot an optional extra on the tent card (fabric pulled tight as the same kind of job as a tie) and say how they know.

Cross-curricular hook

Link to Maths shape: the capital A and the triangle base that keeps the frame standing under load.