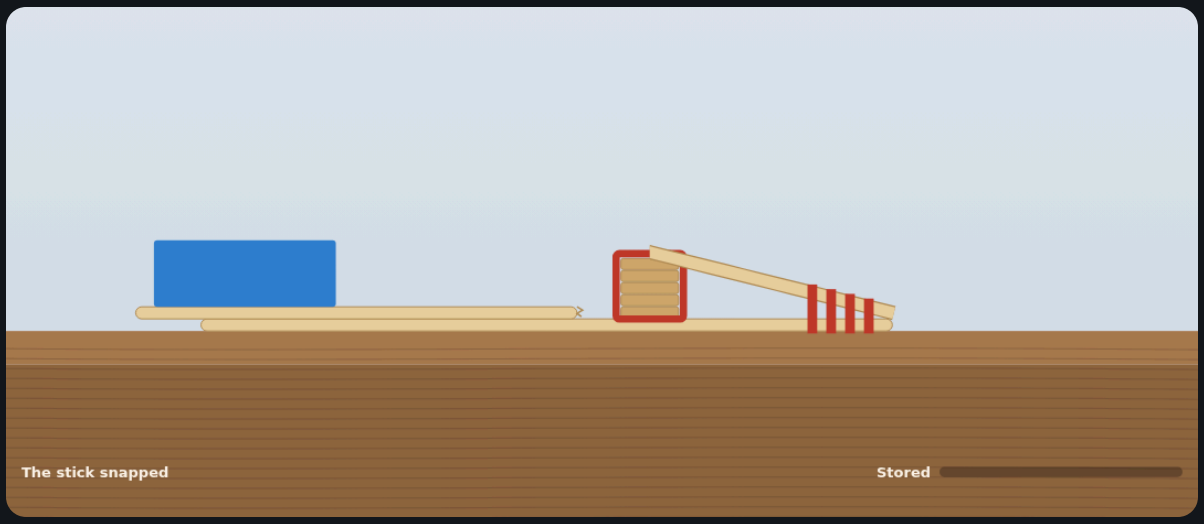
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Catapult Lab: Until It Snaps

Grades 6-8 · 45 minutes

Physical science · Engineering



Slides, rubric and answer key **Print and go** **No student accounts**

Chromebook friendly

What's included

- A one-page overview: objectives, essential question, vocabulary, standards and assessment
- A 45-minute lesson sequence: warm-up, direct instruction, guided practice, independent practice, closure
- Slides for the board: a PowerPoint file that also opens in Google Slides
- A student worksheet with a QR code and a band table
- A 3-question exit ticket, two to a page, with an answer key
- A rubric: 3 criteria, 4 levels, scored out of 12
- Differentiation for English learners, students with IEPs or 504 plans, and students who need more support or more challenge
- Cross-curricular extensions, and notes for teaching it in grades 4 and 5 and in high school physics
- Standards: NGSS

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Students add bands to the banded end of a craft-stick catapult and throw after each: 0.39 m with one, 0.56 with two, 0.66 with three. With four, a full press snaps the stick at about 21 mm. Two sticks banded together hold four bands and throw 0.80 m; two glued, 0.96 m. Students write the criteria and the constraint, compare the designs, and choose.

At a glance

ESSENTIAL QUESTION

How strong can you make a catapult before it breaks?

OBJECTIVES

Students will be able to:

- add one band at a time and record how far each build throws
- find the point where the stick snaps
- name a criterion and a constraint for a catapult design
- compare three tops and choose the best one that does not break

VOCABULARY

Criteria, Constraint, Stiff, Stress, Trade-off

STANDARDS

MS-ETS1-1, MS-ETS1-2

TIME AND MATERIALS

45 minutes, grades 6-8.

- One computer or Chromebook per student
- A projector
- The worksheet and exit ticket, one copy each per student
- The rubric, one copy per student if you grade the work

PREP

Make copies of the worksheet and exit ticket. Before class, open mytekdev.com/try/catapultlab?lesson=until-it-snaps&ref=tpt-catapultlab-3 once on a student computer: it opens on the built catapult with one band. Run it yourself, about ten minutes: press all the way and let go at one, two and three bands (0.39, 0.56, 0.66 m); at four, move Press all the way and watch it snap; then Put on a new stick, Two sticks glued, and throw (0.96 m).

ASSESSMENT

- Formative: the questions under What to look for, asked while students work, and the exit ticket (answer key included).
- Summative: the worksheet, scored with the rubric.

TECHNOLOGY AND PRIVACY

Runs in any browser, Chromebooks included, with nothing to install. Students need no account and no email: the link works signed out, and nothing they do is stored on our server unless they choose to save.

Lesson sequence

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
0 to 5	**Warm-up** Hook	Show the title, essential question and Today I can slides (about 1 minute). Then the warm-up: how far with four bands? Write the guesses on the board.	Answer the warm-up on the worksheet.
5 to 12	**Direct instruction (I do)** Model it	Project the app. Press all the way and let go: 0.39 m. Show the stat slide, then the snap slide. Introduce criteria (throw far) and constraint (do not snap). **It's working when:** The bands hold the banded end down. More bands make the catapult stiffer, so the same press stores more, and bends the stick harder. A standard craft stick breaks when the wood is pulled apart hard enough over the stack; with four bands that happens at about 21 mm, just before the cup reaches the base at 23 mm.	Watch, and fill in the vocabulary on the worksheet.
12 to 22	**Guided practice (We do)** Up to the snap	Students open the link or scan the QR code. A short guide walks them from one band to the snap and then to the glued top. Ask what changed when they glued two sticks. **Watch for:** Students who keep pressing after the snap. The stick stays broken until Put on a new stick is pressed.	Fill in the first rows of the band table.
22 to 38	**Independent practice (You do)** The strongest top	Students try One stick, Two sticks banded and Two sticks glued with one to four bands each, recording the distance or "snapped", then choose. Walk the room with the What to look for questions. **If they ask:** "The glued top throws farthest. What would make you choose a different one for a real build?" The trade-off	Fill in the table, choose a design and give two reasons.
38 to 45	**Closure** Showcase and exit ticket	Show the Showcase slide. Two students defend their choice. Go back to the warm-up guesses: did four bands throw four times as far? Hand out the exit ticket.	Answer the exit ticket.

Before you teach: a ten-minute walkthrough

Open mytekdev.com/try/catapultlab?lesson=until-it-snaps&ref=tpt-catapultlab-3. A short guide opens over the app. The catapult is built with one band at the banded end. The shelf has Bands at the end (one to four) and Top stick (One stick, Two sticks banded, Two sticks glued).

1. **One to three bands.** Press all the way (to the base, 23 mm) each time: 0.39 m, 0.56 m, 0.66 m.
2. **The snap.** Four bands, one stick: move Press slowly. At about 21 mm the stick snaps over the stack and is drawn broken. The card says the stick gave out long before the bands did.

3. **Stronger tops.** Put on a new stick. Four bands: Two sticks banded 0.80 m, Two sticks glued 0.96 m, and neither snaps. Glued, the two act as one stick twice as thick.

> The moment that lands is the snap at four bands. Students expect more bands to mean more distance, with no limit.

Background for the teacher

Pressing the cup bends the top stick over the stack and lifts the banded end against the bands. Both store energy, like two springs one after the other. More bands make the banded end harder to lift, so the same press stores more energy and bends the stick harder. A standard craft stick is birch about 2 mm thick; the app breaks it when the wood is stressed past about 65 million pascals, a little under birch's strength, because wood varies.

Two sticks banded together share the load, so each bends less. Two glued act as one stick twice as thick, which is eight times as stiff and four times as strong in bending. Each extra band also adds less distance than the one before, because the stick bends more and the cup still has to be swung. Catapult Lab works out each throw from the build: how stiff the stick and the bands are, how heavy the cup and the projectile are, and the air. Two of its numbers are estimates still to be measured (how hard the bands hold the end down, and that they give back 75% of what was stored), so a real catapult can land well short of the drawing or past it. The app never claims more: every speed and energy is shown as "about".

What to look for

Ask these while students work. A student who has understood the lesson can answer them without help:

- Did each band add the same distance? How do you know?
- What broke first, the stick or the bands?
- Why did two glued sticks hold four bands?
- What is your criterion, and what is your constraint?
- What did you give up to get your design?

> The fourth question is the real test: a student who can say "throw far" and "do not snap" in their own words, and judge a design by both, has the idea.

Cross-curricular extensions

- Math: graph distance against number of bands for each top. Which graph flattens first?
- Building: test real tops, single and glued, with one to three bands, five throws each. Eye protection for everyone the whole time, building too. Light, soft things only: pom-poms, marshmallows, ping pong balls. Aim at a target on the floor, never at a person. A stick can snap and splinter, so press slowly.
- English: write a short recommendation for a class contest, with your data and your trade-off.

- Careers: bridge and building engineers set a "factor of safety". Find out what it is, and what yours would be.

Vocabulary

Criteria	What a design has to do to succeed. Here: throw as far as it can.
Constraint	A limit the design has to stay inside. Here: the stick must not snap.
Stiff	Hard to bend. A stiffer catapult needs more push to press the same distance.
Stress	How hard the wood is being pulled apart inside as it bends.
Trade-off	Giving up some of one thing to get more of another.

Differentiation

ENGLISH LEARNERS

- Keep the vocabulary slide up, and point at the screen as you say each word: the arc, the tape and the colored bars carry the meaning.
- Pair each learner with a partner; the broken stick is drawn, and "snapped" is one word to copy.
- Accept the table as numbers and the choice as one sentence.

STUDENTS WITH IEPS OR 504 PLANS

- Pair students for the independent part, one at the app and one filling in the table.
- Zoom the browser to 125%.
- Allow two tops instead of three, where the IEP allows a modified assignment.

STUDENTS WHO NEED MORE SUPPORT

- A sentence starter: "I chose ___ because it threw ___ m and ___."
- A check-in after the guide: every student has the snap in the table before moving on.
- Give the glued and single tops only.

STUDENTS READY FOR MORE

- Set High school: the strip shows how many millijoules are stored. How much more does each band add?
- Try a jumbo stick. Does it snap with four bands?
- Find the most bands and the shortest press that still throws past 0.5 m. Why might a class want a short press?

Adapting for other grades

Younger students: In grades 4 and 5, set the app to Grades 4 and 5 (distances in centimeters, energy in words) and do the guide together on the projector. Pairs share a computer, one on the mouse and one recording. Skip the third rubric row; total 8, and 6 meets the objectives. Compare one stick with two glued, and ask which is stronger and why.

Older students: In high school physics, two springs pull in series here: the bent stick and the bands. Students read the stored millijoules at the same press for one to three bands and explain why the energy does not grow in step with the number of bands.

Student worksheet

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/catapultlab?lesson=until-it-snaps

Essential question: How strong can you make a catapult before it breaks?

Warm-up: If one rubber band throws it 0.39 m, how far will four throw it? _____ m

1. **Vocabulary.** Criteria, constraint, stiff, stress, trade-off: write each in your own words.

2. **The band table.** For each top (one stick, two banded, two glued) and 1 to 4 bands, pressed all the way: how far _____ m, or "snapped".

1. My criterion is _____. My constraint is _____.

2. Which design would you build? What did you give up to get it?

Catapult Lab: Until It Snaps

Exit ticket

Name: _____

1. Adding a fourth band to one stick and pressing all the way (A) throws four times as far (B) snaps the stick (C) breaks a band

2. Two sticks glued together held four bands because they are (A) heavier (B) stiffer and stronger (C) longer

3. Name one criterion and one constraint for a classroom catapult.

Catapult Lab: Until It Snaps

Exit ticket

Name: _____

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Answer key: exit ticket

QUESTION	ANSWER	WHY
1	B	With four bands the stick breaks at about 21 mm, before the cup reaches the base at 23 mm.
2	B	Glued, they bend as one stick twice as thick: much stiffer and stronger.
3	Criterion: throw far. Constraint: do not snap	Any fair pair counts, such as "lands in the target" and "uses 8 sticks or fewer". A criterion is what it must do; a constraint is a limit.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
The band table	All three tops with one to four bands, each with a distance or "snapped".	At least two tops, each with a distance or "snapped".	Some builds recorded.	No builds recorded.
Criteria and constraint	Names the criterion and the constraint in their own words and uses both to judge a design.	Names a criterion and a constraint.	Names one of them.	No answer.
Choosing a design	Chooses the best design that did not snap, with its distance, and names what was traded for it.	Chooses a design that did not snap, with a reason.	Chooses the farthest throw, with no reason.	No answer.

Total: ____ / 12. A score of 9 or more meets the objectives.

Standards

The lesson is built for MS-ETS1-1 and MS-ETS1-2: students state the criterion and the constraint precisely, then compare designs against both.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
NGSS	**MS-ETS1-1**	6-8	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	Students state the criterion (throw far) and the constraint (do not snap) from what the app shows at the breaking point.
NGSS	**MS-ETS1-2**	6-8	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	Students compare three tops with one to four bands against both and choose the best that holds.

Checked November 2026 against: NGSS MS-ETS1, Engineering Design.

Optional: save student work in a free class

The whole lesson runs at the link on the worksheet, with no accounts and no sign-up.

To keep students' work, and see it all in one place, make a free class. It takes about ten minutes, once, and covers every lesson in this series: mytekdev.com/tools/class-setup

Students in a class open mytekdev.com/tools/catapult-lab/lessons/until-it-snaps/start instead of the worksheet link. Each one gets their own copy of the starter, and the same link reopens it next time.

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