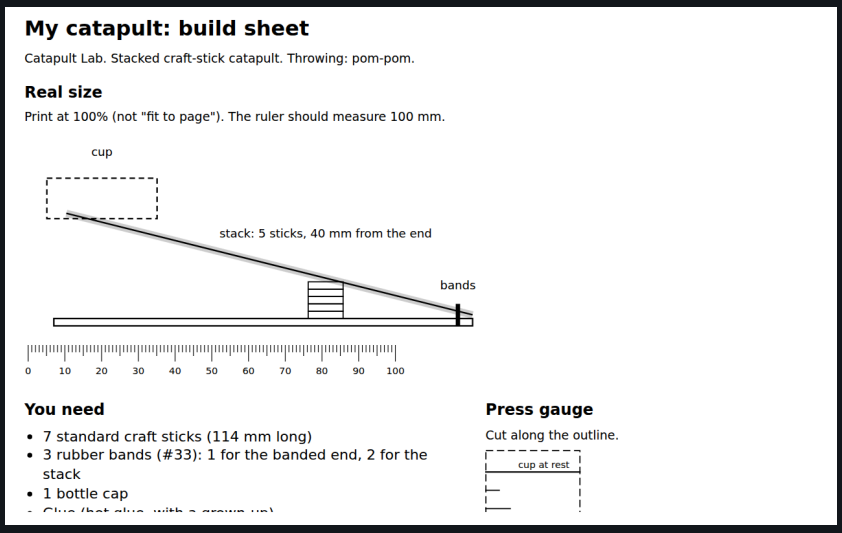
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Catapult Lab: Build It, Test It, Tune It

Grades 6-8 · 45 minutes

Physical science · Engineering


My catapult: build sheet

Catapult Lab. Stacked craft-stick catapult. Throwing: pom-pom.

Real size

Print at 100% (not "fit to page"). The ruler should measure 100 mm.

You need

- 7 standard craft sticks (114 mm long)
- 3 rubber bands (#33): 1 for the banded end, 2 for the stack
- 1 bottle cap

Press gauge

Cut along the outline.

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 real-throw 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

Catapult Lab: Build It, Test It, Tune It

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Students throw the classic catapult on the screen (0.39 m), print the build at real size, build the real one in groups, throw it five times with the press gauge, and type the distances into the app. The app works out how much less of the push the real one gives the throw and tunes its next drawings to it. Groups then change one thing, predict with the tuned model, and test it for real.

At a glance

ESSENTIAL QUESTION

How close can a model get to the real thing, and what do you learn from the gap?

OBJECTIVES

Students will be able to:

- build a catapult from a real-size plan
- throw it five times the same way and record the distances
- compare the real throws with the model and give reasons for the difference
- use the tuned model to predict a change, then test it

VOCABULARY

Model, Prediction, Mean, Spread, Tune

STANDARDS

MS-ETS1-4, MS-ETS1-3

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
- Per group: 8 standard craft sticks, 4 #33 rubber bands, a plastic bottle cap, glue, 5 pom-poms
- A tape measure and masking tape for the floor
- Eye protection for every student
- The printed build sheet, one per group

PREP

Print the build sheet once from the app (Print the build, at 100%) and check that its ruler measures 100 mm; print one per group. Make copies of the worksheet and exit ticket. Put out the kits. Before class, open mytekdev.com/try/catapultlab?lesson=build-it-test-it-tune-it&ref=tpt-catapultlab-4 once on a student computer: press all the way and let go

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.

(0.39 m), press Print the build, and under Your real one type 0.31 and press Add to see the tuning.

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). Throw the classic catapult on the projector: 0.39 m. Then the warm-up: will yours throw the same?	Write a prediction on the worksheet.
5 to 10	**Direct instruction (I do)** The plan and the rules	Show the build sheet slide. Point at the ruler, the press gauge and the safety box. Eye protection on now, for building too. > **It's working when:** 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.	Read the parts list and steps with their group.
10 to 22	**Guided practice (We do)** Build it	Groups build from the sheet, checking each part against the real-size drawing. Glue needs a few minutes: build while it sets. > **Watch for:** The stack too far from the banded end, or the cap too far in. Lay the catapult on the drawing: the stack should sit 40 mm from the band.	Build the catapult and cut out the press gauge.
22 to 38	**Independent practice (You do)** Test it, then tune it	Groups throw five times, pressing to the gauge line, measuring from the banded end to where the pom-pom first touches. One student types each distance under Your real one. Then each group changes one thing, predicts with the tuned app, and tests it. > **If they ask:** "Your five throws were not all the same, and the drawing's are. What made yours spread out?" The gap	Fill in the real-throw table, the mean and spread, then the prediction and test.
38 to 45	**Closure** Showcase and exit ticket	Show the Showcase slide. Groups say how close their prediction was and give two reasons for the gap. Hand out the exit ticket.	Answer the exit ticket.

Before you teach: a ten-minute walkthrough

Open mytekdev.com/try/catapultlab?lesson=build-it-test-it-tune-it&ref=tpt-catapultlab-4. A short guide opens over the app. The catapult is built with one band and a bottle cap, the build the sheet prints.

1. **The drawing.** Move Press all the way and press Let go: 0.39 m, and 0.65 m with no air.
2. **The sheet.** Press Print the build. One page: the catapult at real size, a 100 mm ruler, parts, steps, a press gauge to cut out, where it should land, and a safety box. Print at 100% and check the ruler.

3. **Tuning.** Under Your real one, type a real distance, for example 0.31, and press Add. The app says the real one reached about 80% of the drawing's distance and how much less energy that takes, and the next throw of this build lands near 0.31 m, marked "Tuned to your real one".

> The moment that lands is the first real throw. Students expect the screen and the table to agree; the gap is the lesson.

Background for the teacher

The drawing lands in the same place every time. A real catapult does not: the press is never exactly the same, the bands differ from the drawing's, glue and the base give a little, the stick and cup shake. Five throws give a mean and a spread. The app tunes one number, how much of the push the real one gives the throw, to match the mean, and keeps the rest of the model.

Distance and energy do not shrink by the same share, so a real one that reaches 80% of the distance is not exactly 80% of the energy; the app says so. Tuning can be turned off in Setup. 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:

- How far was your real catapult from the drawing, as a number?
- Why were your five throws not all the same?
- Give two reasons your catapult differs from the drawing.
- What did tuning change, and what did it keep?
- How close was your prediction for the change?

> The third question is the real test: a student who names something specific about their own build (the bands, the glue, the press) has understood that the gap is data.

Cross-curricular extensions

- Math: find the mean and the spread of five throws, then of ten. Does the mean settle?
- Math: what share of the drawing's distance did your catapult reach, as a percent?
- English: write a short lab report: question, prediction, method, data, what the gap means.
- Careers: engineers tune computer models with test data. Find one example, from bridges, cars or rockets.

Vocabulary

Model	A simpler version of something real, used to test ideas.
Prediction	What you expect to happen, written before the test.
Mean	The total of the throws divided by how many there were.
Spread	How far apart the shortest and longest throws are.
Tune	To change a model so it matches what really happened.

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.
- Give each group a role card: builder, presser, measurer, typist.
- Accept the table as numbers and the reasons as words from the list on the slide.

STUDENTS WITH IEPS OR 504 PLANS

- Pre-cut the press gauge, and pre-band the stack.
- A measuring partner reads the tape while the student records.
- Three throws instead of five, where the IEP allows a modified assignment.

STUDENTS WHO NEED MORE SUPPORT

- A sentence starter: "Our catapult landed ___ m. The drawing said ___ m. One reason is ___."
- Build the stack for the group before class.
- Skip the change-one-thing test; compare only the five throws with the drawing.

STUDENTS READY FOR MORE

- Change two things, one at a time, predicting each with the tuned app.
- Find the mean and the spread. Would ten throws change the mean much?
- Try A steady real one under Challenges: three throws inside 20 cm.

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. Build one catapult as a class, with students taking turns to press and measure.

Older students: In high school, students measure the launch speed with a phone in slow motion (count the frames for 10 cm of rise) and compare with the speed the app gives at High school level, before and after tuning.

Student worksheet

Name: _____ Date: _____

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

Essential question: How close can a model get to the real thing, and what do you learn from the gap?

Warm-up: The app says this catapult throws 0.39 m. Will yours, built from the same plan? _____ Why?

1. **Vocabulary.** Model, prediction, mean, spread, tune: write each in your own words.

2. **The real-throw table.** Five throws: ____ ____ ____ ____ ____ m. Mean _____ m. Spread _____ m. The drawing _____ m. Change I made _____. Prediction _____ m. Real _____ m.

1. Give two reasons your catapult did not land where the drawing did.

2. How close was your prediction after tuning? Was the model useful?

Catapult Lab: Build It, Test It, Tune It

Exit ticket

Name: _____

1. Your five real throws landed at different distances because (A) the press, the bands and the build are never exactly the same (B) the model is wrong (C) gravity changes

2. Tuning the model to your real catapult changes (A) everything in the model (B) one number, how much of the push your catapult gives the throw (C) nothing

3. Why test a model against a real build at all?

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3. Why test a model against a real build at all?

Answer key: exit ticket

QUESTION	ANSWER	WHY
1	A	Real throws spread out; the drawing does not. The spread is real data about the build.
2	B	It keeps the stick, the bands, the cups and the air, and changes one efficiency to match your mean.
3	To find out how far to trust it	A model is only useful once you know how close it gets. "To check it" alone is half; the best answers say the gap shows what the model leaves out.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
The real-throw table	Five throws, the mean and the spread, and a prediction and test of one change.	Five throws and the mean.	Some throws recorded.	No throws recorded.
Comparing model and real	Gives the gap as a number and two specific reasons from the build.	Gives the gap and one reason.	Says it was different, with no reason.	No answer.
Using the tuned model	Predicts a change with the tuned app, tests it, and says how close the prediction was.	Predicts and tests a change.	Tests a change with no prediction.	No answer.

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

Standards

The lesson is built for MS-ETS1-4 and MS-ETS1-3: students test a model against the real object, tune it with their data, and use it to predict a change before they test it.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
NGSS	**MS-ETS1-4**	6-8	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	Students use the app as a model, tune it to their real catapult, and use it to predict a change.
NGSS	**MS-ETS1-3**	6-8	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	Students analyze their real throws against the model to decide what to change.

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/build-it-test-it-tune-it/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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