Family edition

# Catapult Lab: Build It, Test It, Tune It

Ages 11-14 · about 60 minutes, in one sitting

Your child prints a real-size plan of a popsicle stick catapult from Catapult Lab, builds it with you, and tunes the app to it.

## What you need

- A computer or Chromebook with a current browser, and a mouse or trackpad.
- The lesson link: mytekdev.com/try/catapultlab?lesson=build-it-test-it-tune-it&ref=fam-catapultlab-4. No account, no email and nothing to install.

## Before you start: try it once yourself

Open mytekdev.com/try/catapultlab?lesson=build-it-test-it-tune-it&ref=fam-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. Children expect the screen and the table to agree; the gap is the lesson.

## The ideas, in plain words

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".

## Do it together

1. Open mytekdev.com/try/catapultlab?lesson=build-it-test-it-tune-it&ref=fam-catapultlab-4 together. Move `Press` all the way and press `Let go`.

   > **You'll know it worked when:** The drawing lands the pom-pom at 0.39 m.

2. Press `Print the build`, print at 100%, and check the ruler measures 100 mm. Build it together. 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.

   > **If you get stuck:** If the ruler is short, the printer shrank the page: print at actual size.

3. Throw it five times, pressing to the gauge line, and measure from the banded end.

   > **You'll know it worked when:** The five throws will not all be the same, and probably not 0.39 m.

4. Type each distance under `Your real one` and press `Add`. Throw on the screen again.

   > **You'll know it worked when:** The drawing now lands where your catapult does, marked "Tuned to your real one".

## Talk about it

Ask these while you work together. A child who has understood it 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 child who names something specific about their own build (the bands, the glue, the press) has understood that the gap is data.

## For younger and older kids

**Younger:** For a younger child, build it together and let them press and measure; compare only the distances.

**Older:** For a teenager, film a throw in slow motion and work out the launch speed from the frames.

## Keep going

- 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.

## Bring it into other subjects

- 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.

## For your records

Ready to copy into an hour log, a portfolio or a transcript.

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|---|---|
| **LESSON** | Catapult Lab: Build It, Test It, Tune It |
| **SUBJECTS** | Physical science, Engineering |
| **TIME** | 60 minutes |
| **WHAT WE DID** | Built a catapult from a real-size plan, tested it five times, compared it with a computer model and tuned the model to it. |
| **SKILLS PRACTICED** | Engineering design; Measuring; Models and data |

## Activity sheet (optional)

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?

## Quick check

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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## Answers

| 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. |

If your state or umbrella school asks, this lesson covers NGSS MS-ETS1-4, NGSS MS-ETS1-3.

## Terms of use

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The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

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