Family edition

Catapult Lab: Where Did the Push Go?

Ages 11-14 · about 45 minutes, in one sitting

Your child throws a pom-pom and a ping pong ball from a popsicle stick catapult in Catapult Lab and finds out where the push goes.

What you need

- A computer or Chromebook with a current browser, and a mouse or trackpad.
- The lesson link: mytekdev.com/try/catapultlab?lesson=where-did-the-push-go&ref=fam-catapultlab-1. No account, no email and nothing to install.

Before you start: try it once yourself

Open mytekdev.com/try/catapultlab?lesson=where-did-the-push-go&ref=fam-catapultlab-1. A short guide opens over the app. The craft-stick catapult is built, with a pom-pom in a bottle cap. The shelf on the right picks the projectile and the cup.

1. **The first throw.** Move Press all the way: the strip says "Pressed 23 mm: on the base". Press Let go. The pom-pom flies high and back over the banded end and lands at 0.39 m. The dashed arc, the same throw with no air, lands at 0.65 m.
2. **The card.** Energy, letting go: to the pom-pom 9%, still swinging the cup and stick 66%, turned into heat, mostly in the bands 25%. Energy, in the flight: still moving when it landed 56%, taken by the air 44%.
3. **Five more throws.** Bottle cap: mini marshmallow 0.52 m (14% to it), ping pong ball 0.29 m (34%). Paper liner: pom-pom 0.78 m (24%), mini marshmallow 1.21 m (33%), ping pong ball 0.50 m (55%).

> The moment that lands is the ping pong ball. It gets more than three times the pom-pom's share of the push and still lands short: it is almost seven times heavier, so that share moves it slower.

The ideas, in plain words

Pressing the cup bends the top stick and stretches the bands at the banded end. Let go, and they give back about three quarters of what they stored; the rest becomes heat. What comes back has to move everything on the arm: the stick, the cup and the projectile. A heavy cup on a light projectile keeps most of it, so the projectile leaves with only a small share.

A heavier projectile takes a bigger share of the push, but the same energy moves a heavier thing slower. Then the air: it pushes against anything moving through it, and a light, fluffy pom-pom feels it about as much as its own weight at launch. The air takes 44% of the pom-pom's energy and only 12% of the ping pong ball's. 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=where-did-the-push-go&ref=fam-catapultlab-1 together. A short guide opens over the app. Move `Press` all the way and press `Let go`.

   > **You'll know it worked when:** The pom-pom lands at 0.39 m. The card says about a tenth of the energy went to it.

2. Tap `Ping pong ball` and throw again.

   > **If you get stuck:** The card changes only after `Let go` is pressed again.
   >
   > **You'll know it worked when:** It lands at 0.29 m, and got about a third of the push.

3. Tap `Paper cupcake liner` and `Pom-pom`, and throw again.

   > **You'll know it worked when:** It lands at 0.78 m, twice as far, with about a quarter of the push.

4. Ask: where did the rest of the push go?

   > **You'll know it worked when:** Most of it kept the cup and stick swinging; a quarter turned into heat in the bands.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- Where did most of the push go on your first throw?
- Why does a heavy cup keep so much of it?
- The ping pong ball got a bigger share and landed shorter. How?
- Which projectile does the air slow the most, and how can you tell from the screen?
- Which change made the biggest difference: the cup or the projectile?

> The second question is the real test: a child who says the cup and stick have to move too, and a heavy cup takes more to move, has the idea.

For younger and older kids

Younger: For a younger child, set Grades 4 and 5 and compare only the distances in centimeters and which part of the bar is biggest.

Older: For a teenager, set High school and check that the energy given to the pom-pom matches one half m v squared.

Keep going

- Set the level to High school: the card gives the energy in millijoules. Add up what went where. Does it come to what was stored?
- Find the projectile and cup that land farthest. Is it the one with the biggest share to the projectile?
- Compare the second bar for the pom-pom and the ping pong ball. Why does the air take so much more from the pom-pom?

Bring it into other subjects

- Math: make a bar graph of distance for the six throws, grouped by cup. What does the liner do to every projectile?
- Math: the bottle cap weighs 2.5 g and the pom-pom 0.4 g. How many times heavier is the cap?
- Building: make a real catapult with a bottle cap, then a paper liner, and throw a pom-pom five times from 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 paragraph that argues, with evidence from the bars, which cup a class should use.

For your records

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

LESSON	Catapult Lab: Where Did the Push Go?
SUBJECTS	Physical science, Engineering
TIME	45 minutes
WHAT WE DID	Threw three projectiles from two cups in a catapult simulation, recorded the distances, and explained where the stored energy went.
SKILLS PRACTICED	Energy transfer; Recording data; Explaining with evidence

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/catapultlab?lesson=where-did-the-push-go

Essential question: When a catapult lets go, where does the energy it stored go?

Warm-up: You press a catapult down and let go. Where does all that push go? _____

1. **Vocabulary.** Energy, stored energy, energy transfer, projectile, air resistance: write each in your own words.

2. **The throw table.** For each cup (bottle cap, paper liner) and each projectile (pom-pom, mini marshmallow, ping pong ball): how far _____ m; share to the projectile _____ %.

1. Where did most of the push go from the bottle cap? Use the bars.

2. Why did the pom-pom go twice as far from the paper liner?

Quick check

Name: _____

1. A pom-pom in a heavy bottle cap: most of the energy goes (A) to the pom-pom (B) into swinging the cup and stick (C) away as sound

2. The ping pong ball got a bigger share of the push than the pom-pom but landed shorter, because (A) it is heavier, so the same push makes it slower (B) the air took more from it (C) it was pressed less

3. Explain why a lighter cup throws a pom-pom farther.

Answers

QUESTION	ANSWER	WHY
1	B	The cup and stick have to swing too; a heavy cap keeps about two thirds of the energy.
2	A	It is almost seven times heavier than the pom-pom, so even a bigger share moves it slower. The air takes less from it, not more.
3	Less of the push stays in the cup	A light cup takes less energy to swing, so more goes to the pom-pom: about a quarter instead of a tenth. "It is lighter" alone is half.

If your state or umbrella school asks, this lesson covers NGSS MS-PS3-5.

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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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