Family edition

Flight Lab: How Hard Should You Throw It?

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

Your child throws a paper plane in Flight Lab at every strength from a gentle toss to as hard as an arm can, and finds out whether harder means farther.

What you need

- A computer or Chromebook with a current browser, and a mouse or trackpad.
- The lesson link: mytekdev.com/try/flightlab?lesson=how-hard-should-you-throw-it&ref=fam-flightlab-1. No account, no email and nothing to install.

Before you start: try it once yourself

Open mytekdev.com/try/flightlab?lesson=how-hard-should-you-throw-it&ref=fam-flightlab-1. A short guide opens over the app. The classic dart is picked on the Plane bench. The benches run along the top: Plane, Fold, Shape, Fly, Paint, Mark and Export. This lesson happens on Fly.

1. **The first throw.** Press `Fly`, check Gym is picked under Where, and press `Throw it`. The plane leaves a thrower's hand and glides: "A steady glide: 24 ft in 1.7 s."
2. **Every strength.** Drag How hard to 1 and throw: a dive, 8 ft. 2 and 3 glide, 16 and 24 ft. 4, 5 and 6 climb, then dive: 28, 29 and 25 ft. From 7 up it loops: 28 ft at 7, about 44 ft at 8 and 9, 40 ft at 10.
3. **Ten throws.** Set How hard to 3 and press `Throw it ten times`: "Ten throws: 22 ft to 25 ft." Half landed past 24 ft.

> The moment that lands is How hard 4. Children expect a harder throw to glide farther; instead it climbs and dives. On a slow computer, press Diagram under Watch: it shows the same flight from the side and from above.

The ideas, in plain words

The wings lift more the faster the air goes over them: twice as fast is four times the lift. A glide is the speed where lift and weight balance; the classic dart, with its back edges bent as it came, settles to about 11 mph. A paper plane is so light that the arm, not the plane, sets how fast it leaves the hand, and How hard 3 is 15 mph.

Thrown much faster, the plane has far more lift than weight, so it climbs. Climbing slows it down, its nose tips over, and it dives. Thrown harder still, it climbs right over the top: a loop. Those flights can land farther than the glide, but a small change in the throw moves where they land.

Children may have heard of a stall: the wings meet the air too steeply, the air stops flowing smoothly over them, and they lose lift. A short, pointed paper wing can meet the air very steeply before that happens, so in Flight Lab these throws tip over first. Common mistakes: harder is always farther; one throw tells you what a plane does. Flight Lab works out each flight from the folded shape and the throw. A few of its numbers are our own, set where no published

measurement exists, so a real paper dart lands near the distances on screen, not exactly at them. Real throws also vary more than the app's, real paper softens with use, and the app never shows a stall: its short paper wings tip over before they would stall.

Do it together

1. Open mytekdev.com/try/flightlab?lesson=how-hard-should-you-throw-it&ref=fam-flightlab-1 together. A short guide opens over the app. Press `Fly`, then `Throw it`.

   > **You'll know it worked when:** The plane glides across a gym: a steady glide of 24 ft.

2. Drag How hard to 1 and press `Throw it`. Then try 5.

   > **If you get stuck:** The result changes only after `Throw it` is pressed again.
   >
   > **You'll know it worked when:** At 1 it dives to the floor at 8 ft. At 5 it climbs, slows, and dives: 29 ft.

3. Throw at every strength from 1 to 10 and write down what each throw did.

   > **You'll know it worked when:** From 7 up it loops. At 8 the loop carries it about 44 ft.

4. Set How hard to 3 and press `Throw it ten times`. Ask: would you believe one throw?

   > **You'll know it worked when:** Ten throws land between 22 and 25 ft.

Talk about it

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

- What did your plane do at How hard 1, and why do you think it dove?
- Why did a harder throw make it climb?
- What happened to its speed as it climbed?
- Which throw would you trust to land where you wanted?
- Your ten throws did not all land in one place. Why not?

> The second question is the real test: a child who says the faster air gave the wings more lift than the plane's weight has the idea.

For younger and older kids

Younger: For a younger child, try only 1, 3, 5 and 8, and talk about what each throw did.

Older: For a teenager, work out how much more lift the dart has at How hard 5 (24 mph) than in its glide (11 mph): lift grows with the square of the speed.

Keep going

- At How hard 3, change Standing to Kneeling, then to On a step. Does a higher hand go farther? By how much?
- Look at Things to try at the bottom of the Fly bench. Which throw ticks Three seconds in the air?
- Press From the side and Slow motion under Watch and throw at 5. Point at the moment the plane was slowest: what was its nose doing just after?

Bring it into other subjects

- Math: make a bar graph of distance against How hard. Where is the top, and is the graph a smooth curve?
- Math: ten throws landed between 22 and 25 ft. Find the range, and explain what it says about one throw.
- Building: fold a real dart and throw it gently, then hard, five times each. Measure with a tape measure. Which throws scatter more?
- English: write a short guide for a younger child on how to throw a paper plane well, and why.

For your records

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

LESSON	Flight Lab: How Hard Should You Throw It?
SUBJECTS	Physical science, Engineering
TIME	45 minutes
WHAT WE DID	Tested a paper plane at ten throwing strengths, recorded each flight, and explained why a faster throw makes it climb.
SKILLS PRACTICED	Forces and motion; Fair tests; Recording data

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/flightlab?lesson=how-hard-should-you-throw-it

Essential question: Does throwing a paper plane harder always make it go farther?

Warm-up: Should you throw a paper plane as hard as you can to make it go farthest? Why?

_____

1. **Vocabulary.** Glide, lift, weight, climb, loop: write each in your own words.

2. **The throw table.** For How hard 1 to 10: what it did (glide, dive, climb then dive, loop) _____; how far _____ ft. One throw on each line. Then ten throws at 3: from _____ ft to _____ ft.

1. Which throw went farthest? Which throw would you trust to land where you wanted? Why?

2. Why does a plane thrown too hard climb?

Quick check

Name: _____

1. A plane thrown much faster than it likes to fly will first (A) dive (B) climb (C) fly level

2. Why does a climbing plane slow down? (A) Gravity pulls back on it as it goes up (B) The wings get heavier (C) The air gets thinner

3. Your farthest throw was a loop. Explain why it might not be the best throw for a contest.

Answers

QUESTION	ANSWER	WHY
1	B	Faster air gives the wings more lift than the plane's weight, so it climbs.
2	A	Going up, part of the pull of gravity acts against its motion, so it loses speed until its nose tips over.
3	It is hard to predict where it lands	A small change in a hard throw moves where a loop or a climb then a dive lands. The glide lands close to the same place every time, as the ten throws showed. "It is not the farthest" alone is half.

If your state or umbrella school asks, this lesson covers NGSS MS-PS2-2.

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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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