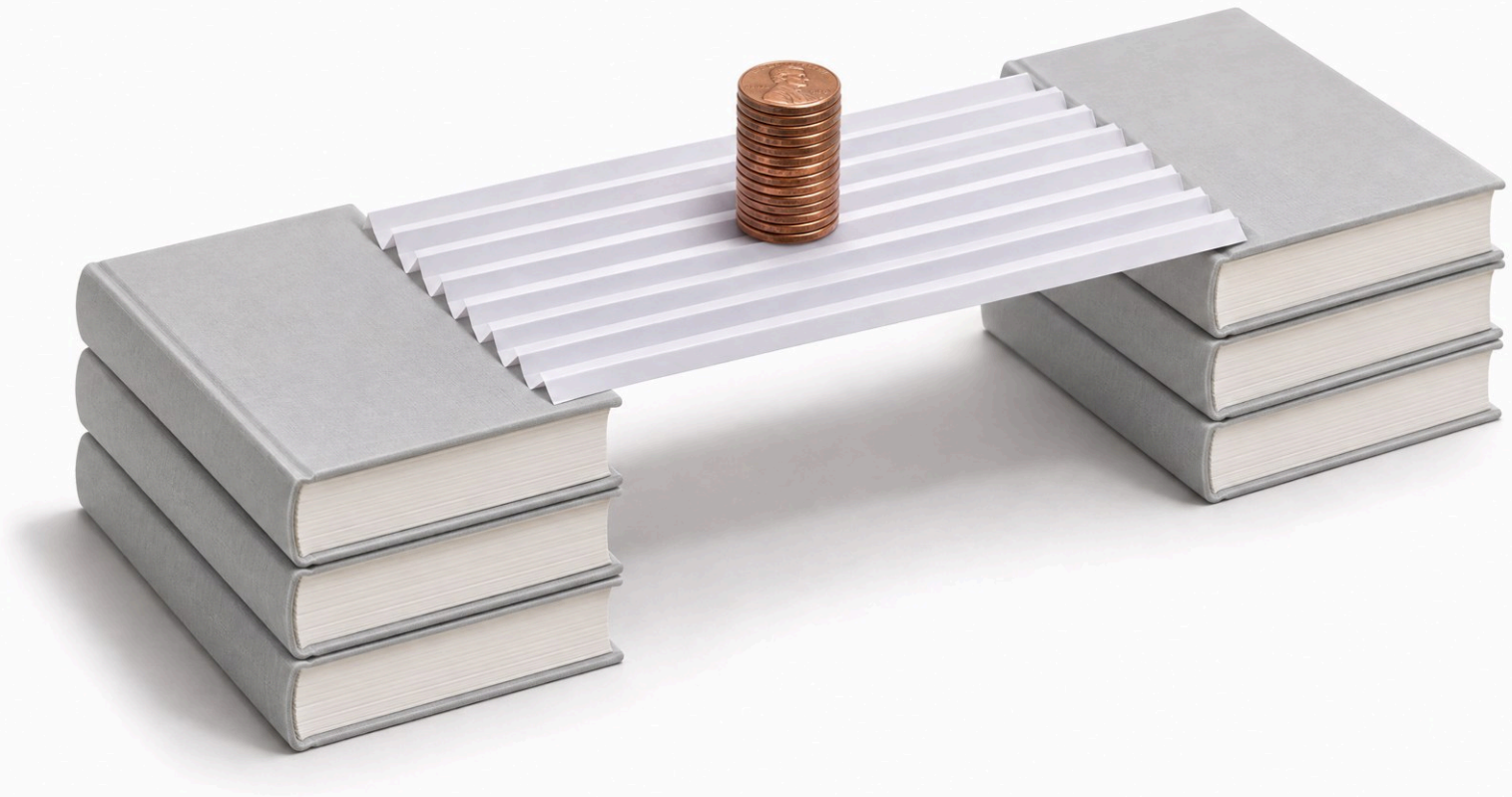
GIVE SPARK



GIVE SPARK · HANDS-ON SCIENCE LAB

# The Paper Bridge Challenge

How does the shape of paper change how much it can hold?

**Teacher Guide**

Grades 3–5 · Engineering and forces · 60 minutes

FREE LAB

OVERVIEW

# The lab at a glance

One lesson, one driving question and three bridges made from three identical sheets of paper.

THE DRIVING QUESTION

## How does the shape of paper change how much it can hold?

Children answer this with coin counts from their own three bridges.

### What children do

Teams lay a flat sheet of paper across a gap between two stacks of books and load it with coins until it fails. They test a second sheet folded into an accordion in the same way. Then they use what they noticed to design a third bridge of their own from one whole sheet, and they test that too.

### What children learn

A sheet of paper bends easily when it lies flat across a gap. Folding the same sheet can make it support a larger load. The material has not changed, so the difference comes from the shape. Children also learn that shapes can be compared only when the paper, the gap, the load and the way of loading stay the same.

### Success looks like

1. I kept the paper, the gap, the coins and the loading position the same for every bridge.
2. I recorded how many coins each bridge held and what happened to it.
3. I used what I noticed in the first two tests to design my own bridge.

### What counts as failure

Agree this with the class before any coins go on. The test ends when the bridge can no longer support the load. It collapses, slips off a support or drops the coins. Bending alone does not have to mean failure.

AT A GLANCE

**Time:** 60 minutes.

**Grouping:** teams of three, with the roles of loader, counter and observer.

**Standards link:** supports NGSS 3-5-ETS1-3, carrying out fair tests in which variables are controlled and failure points are considered.

SESSION PLAN

| STAGE | MIN |
|---|---|
| Introduce the puzzle | 5 |
| Plan the comparison | 7 |
| Test flat and accordion | 15 |
| Design and test | 15 |
| Compare and explain | 10 |
| Close | 5 |
| Clear away | 3 |
| **Total** | **60** |

THE STUDENT RESOURCE

A separate one-page PDF with the fair test, the results table, a space to sketch the team's design and the closing sentences.


© GIVE SPARK PTE LTD 

PREPARATION

# Get ready

What to gather, how to set the gap and one loading rule for every bridge.

## Materials

### For each team

- 3 identical sheets of ordinary printer paper
- 2 stacks of books of equal height
- About 30 identical coins or counters
- A ruler
- A tray to sit beneath the bridge and catch falling coins
- The student page and a pencil

Use the same kind of coin or counter throughout. Teams use no tape, no glue and no extra supports.



The flat bridge. Two equal stacks, one sheet across the gap and coins stacked at the center.

**SAFETY**

Coins fall when a bridge fails, so keep the tray under the gap and fingers out from beneath it. Count the coins back in at the end.

## Set up each station

1. Place the two book stacks on the tray with their inner edges parallel.
2. Set the gap between the inner edges at 15 cm. Children check it with the ruler.
3. Every bridge spans this same gap, with about the same amount of paper resting on each stack.

## The loading rule

1. Position the bridge across the gap.
2. Place coins gently, one at a time, in a single stack at the center.
3. Pause briefly after each coin.
4. Stop when the bridge fails.
5. Record the number it held before the coin that caused the failure.

If a bridge supports every coin the team has, children write “at least” and the number of coins they used, and they record “did not fail”. They do not invent a failure point.

**ROLES**

**Loader:** places each coin.

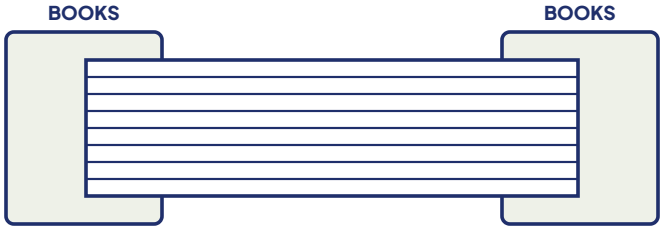
**Counter:** keeps the count aloud.

**Observer:** watches where the paper bends first.

Rotate the roles for each bridge.

## The accordion fold

Fold one long edge of the sheet over by about a finger-width, turn the paper and fold back the other way. Keep going across the sheet, so the folds run along the length of the bridge from one stack of books to the other. Show this only if children need help with the folding technique.




Seen from above: the folds run across the gap



© GIVE SPARK PTE LTD 

# Run the lesson

A sagging sheet raises the question. Three tests with one loading rule answer it.

## Introduce the puzzle 5 MINUTES

**DO** Place a flat sheet across the books and add a few coins at its center. Let the class watch it sag.

**ASK** “Can we make this paper hold more without adding any more paper?”

Collect ideas. Do not demonstrate a successful folded design.

## Plan the comparison 7 MINUTES

**SAY** *“You will compare three bridges. One flat sheet. One sheet folded back and forth into an accordion. One design of your own.”*

**ASK** “What must stay the same so we can compare the shapes?”

Establish the paper type, the gap, the loading position and the coin type. Children write these on the student page. Agree what counts as failure.

## Test the flat and accordion bridges 15 MINUTES

**DO** Teams test the flat bridge with the loading rule and record the count and what happened. They fold the second sheet into an accordion and test it the same way. The observer says where the paper began to bend.

## Design and test 15 MINUTES

**DO** Give teams their third sheet. They sketch an idea first. They may fold or curve the paper, but they must use one whole sheet and keep the same gap. Then they run the same loading rule.

**ASK** “What did you notice in the first tests that influenced this design?”

## Compare and explain 10 MINUTES

**DO** Teams share the shape that held the most and describe what happened as it was loaded.

**ASK**

- “Where did the paper begin to bend? Did the bridge collapse or slide?”
- “Which design feature might explain the difference?”
- “Would one test be enough to claim that this shape always works best?”

## Close 5 MINUTES

**DO** Children complete the sentences on the student page. “Our ___ bridge held ___. We think this happened because ___. One thing we would investigate next is ___.”

Leave 3 minutes to count the coins back in and recycle the paper.

### LOOK FOR

Teams that link a feature of their design to something they saw. “The flat one bent in the middle, so we put our folds across the middle” is the reasoning you want.

### IF THIS HAPPENS

**The bridge slides off the books.** That is a failure. Record it as a slide and ask how the design could grip better without tape.

**A team stacks the coins off center.** Stop, reset and load at the center, so the tests can be compared.

**The accordion springs open.** Crease each fold firmly with a fingernail.

### KEEP THE PUZZLE OPEN

Children get more from finding a strong shape than from copying yours. Help with folding technique and leave the design choices to the team.


© GIVE SPARK PTE LTD 

# The science behind it

Why shape matters, the ideas children bring and how to adjust the challenge.

## The science behind it

Folding changes the structure of the paper and how it resists bending. A flat sheet across a gap has almost no depth, so a small load bends it easily. A folded sheet has height. Each fold acts like a small upright wall, and it takes far more force to bend a tall, thin wall along its length than to bend a flat sheet.

The material is still paper, and the amount of paper is the same. Only the shape has changed, and the shape decides how the bridge carries the load. Engineers use the same idea in corrugated cardboard, in metal roofing and in the beams that hold up buildings.

Avoid the conclusion that more folds always make a stronger bridge. Fold depth, spacing and the way the paper rests on the books can all affect the result. More folds do not automatically mean a stronger bridge, and different shapes fail in different ways.

## Ideas children often bring

| A CHILD MIGHT SAY | YOU COULD RESPOND |
|---|---|
| “Folded paper is stronger paper.” | It is the same paper. Ask what changed, and what stayed the same. |
| “More folds are always better.” | Ask what evidence would show that. It makes a good next investigation. |
| “Ours held the most, so it is the best design.” | It was the best in one test. Ask what they would need to do to be sure. |

## Support and challenge

**Support.** Pre-crease one accordion sheet for a team that struggles with folding, so their time goes on testing and observing.

**Challenge.** Widen the gap to 20 cm and ask teams to predict whether their best design will still hold the most.

### ASSESSMENT

Use the student page and the team discussion.

**Fair test:** names what was kept the same.

**Evidence:** reports counts and describes how each bridge failed.

**Reasoning:** links the design to an observation from an earlier test.

### TAKE IT FURTHER

**Test it again.** Teams rebuild their best design from a fresh sheet and see whether it holds the same number.

**Spread the load.** Compare coins in one central stack with the same coins spread along the bridge.

### FINAL EXPLANATION

Ask every team for the same three things. Tell us what you found, show the evidence, and explain what you think caused it.


© GIVE SPARK PTE LTD 

THANK YOU

# Terms of use

Thank you for downloading this free lab. It is yours to use with your own students, and these terms keep it free for other teachers too.

## You may

- Use this lab with your own class or your own children at home.
- Print or copy the pages for your own students.
- Share the link to the Give Spark store listing with colleagues, so they can download their own copy.

## You may not

- Sell this resource or any part of it.
- Post the files on a public website, shared drive or social media page.
- Edit the files or remove the Give Spark name and copyright.
- Give the files to another teacher. Please send them the link.

## More from Give Spark

If your class enjoyed this lab, the full Give Spark science units work the same way. Each one is built on hands-on investigations and driving questions, is aligned to NGSS and comes with everything you need to teach it.

**Give Spark on TPT**
teacherspayteachers.com/store/give-spark
Follow the store to hear about new free labs.

**give-spark.com**
See every science unit and project in one place.

A rating or a short review on the store listing helps other teachers find this lab, and it is always appreciated.

**Vicky Brooks**
Give Spark


© GIVE SPARK PTE LTD · ALL RIGHTS RESERVED 

# Paper bridge challenge

How does the shape of paper change how much it can hold?

**Name** _____ **Date** _____

## 1 Our fair test

What will we keep the same for every bridge?

## 2 Our results

Add coins one at a time at the center. Write the number the bridge held before the coin that made it fail. If it holds every coin, write “at least ___” and record “did not fail”.

| BRIDGE SHAPE | COINS HELD | WHAT HAPPENED? |
|---|---|---|
| **Flat** | | |
| **Accordion** | | |
| **Our design** | | |

## 3 Our design

Sketch it before you fold. Use one whole sheet.

## 4 Why we chose it

What did you notice in the first two tests?

## 5 What we found

Our _____ bridge held _____ coins.

We think this happened because

One thing we would investigate next is



© GIVE SPARK PTE LTD