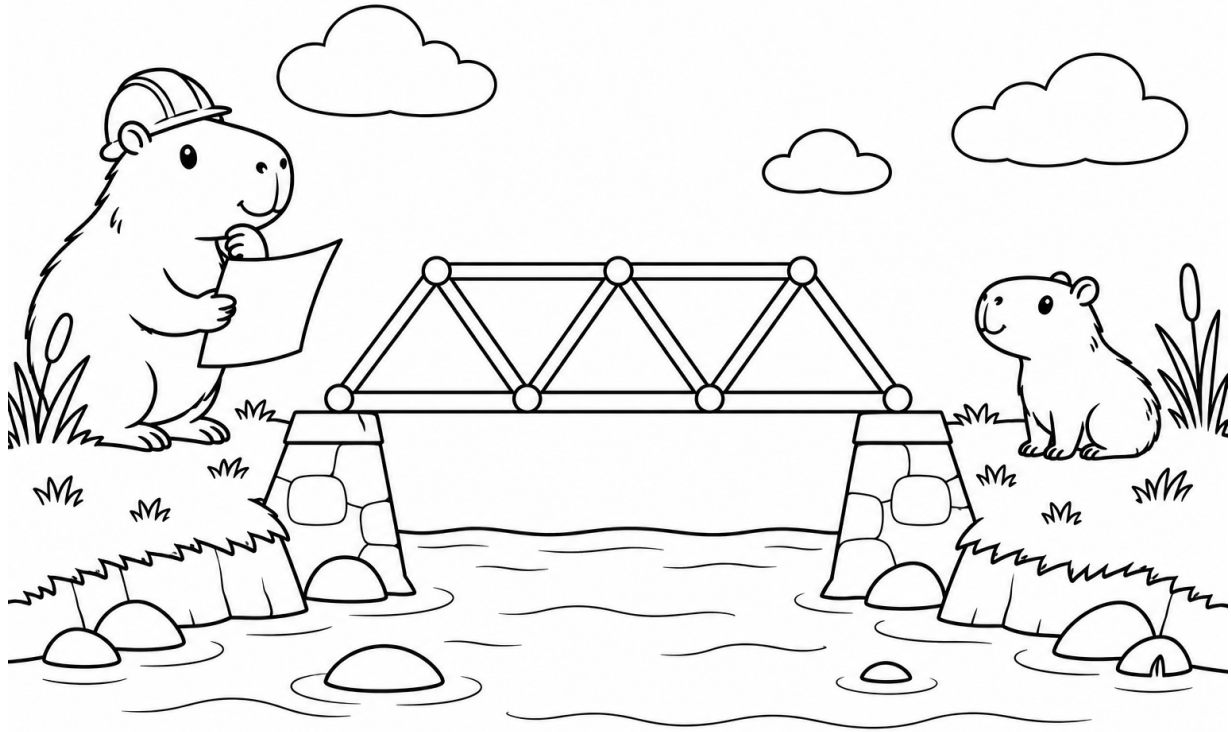


Capybara Bridge Engineering Lab

20 activities to color, build, test and improve. Ages 6-9 with a grown-up nearby.



A river. A delivery. A better idea.

Help a capybara crew cross the river. Start with bridge shapes, then make paper models and use your own test results to improve them.

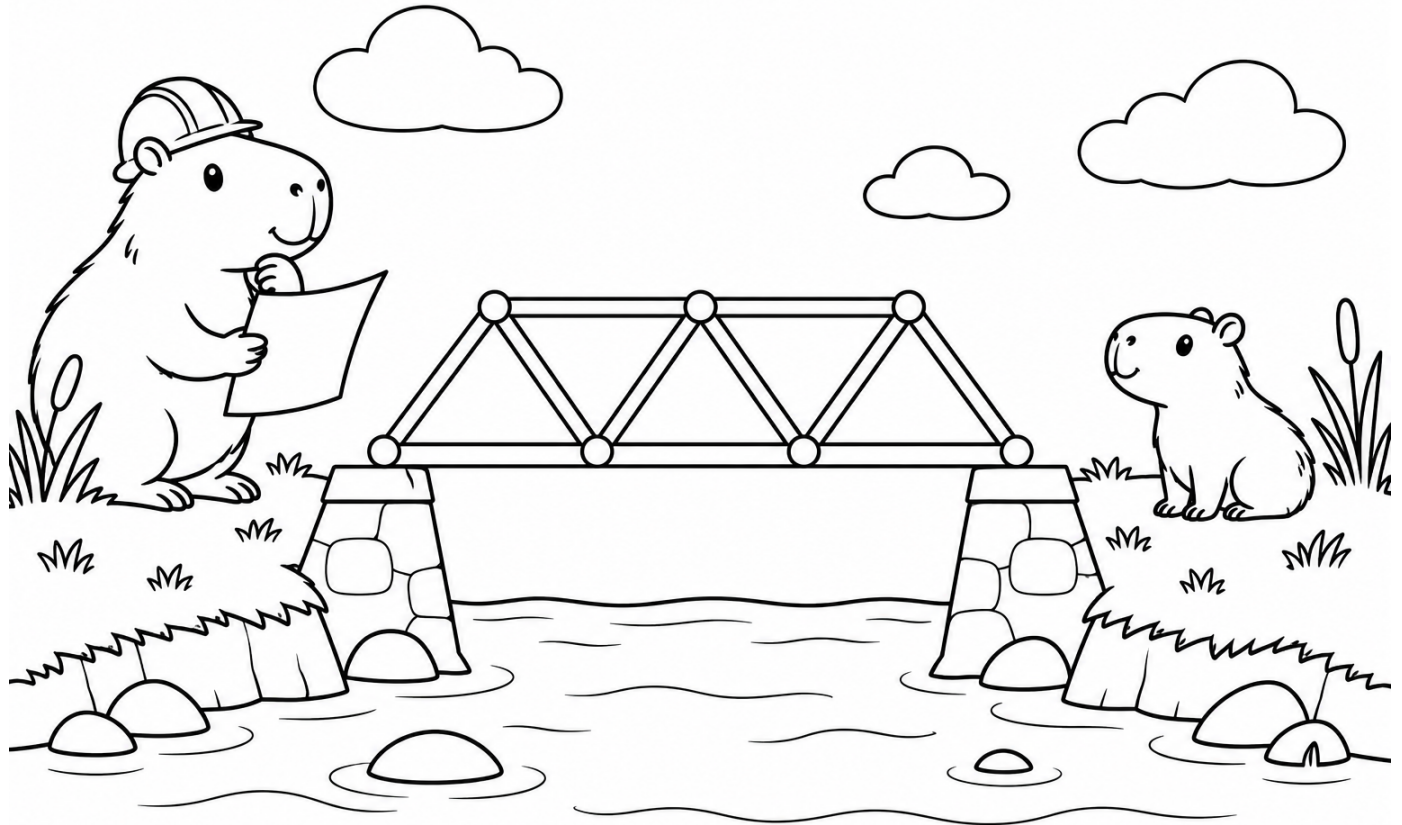
Gather: pencils, child scissors, tape, ruler, 6 sheets of plain paper, scrap card, two equal-height books, string and 10 identical large toy blocks. A grown-up helps with cutting and the test setup.

Print single-sided. Choose A4 or Letter to match your paper. Activities are pages 2-21; grown-up notes and answers are pages 22-24. Try 4 short sessions of about 25-35 minutes; go at your own pace.

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The river delivery

Color the scene. Then circle the three things your bridge must do.



Reach both banks

Carry the delivery

Leave space for water

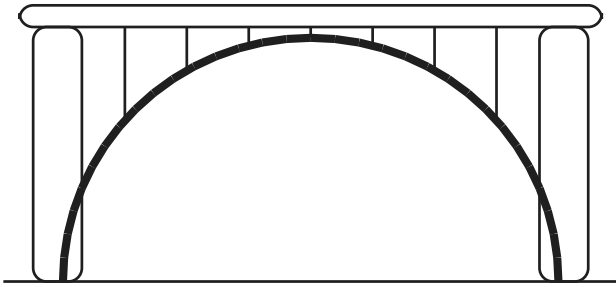
Be made of chocolate

Draw an arrow showing the capybara's route across the bridge.

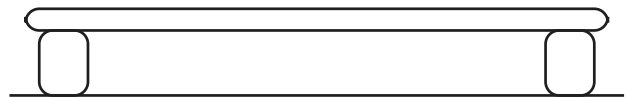
The story picture is imaginary. Engineers begin by asking what a real bridge must do and what limits they have.

Four ways across

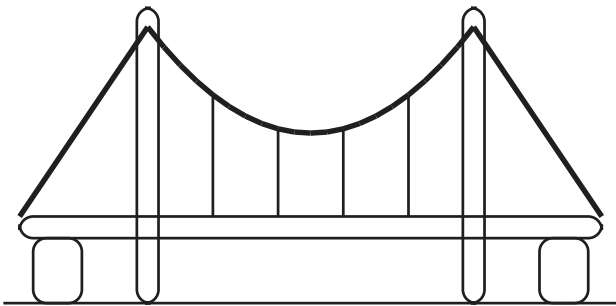
Write the correct bridge name beside each numbered picture.



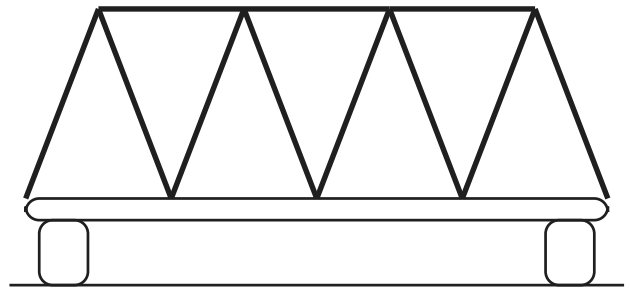
1. _____



2. _____



3. _____



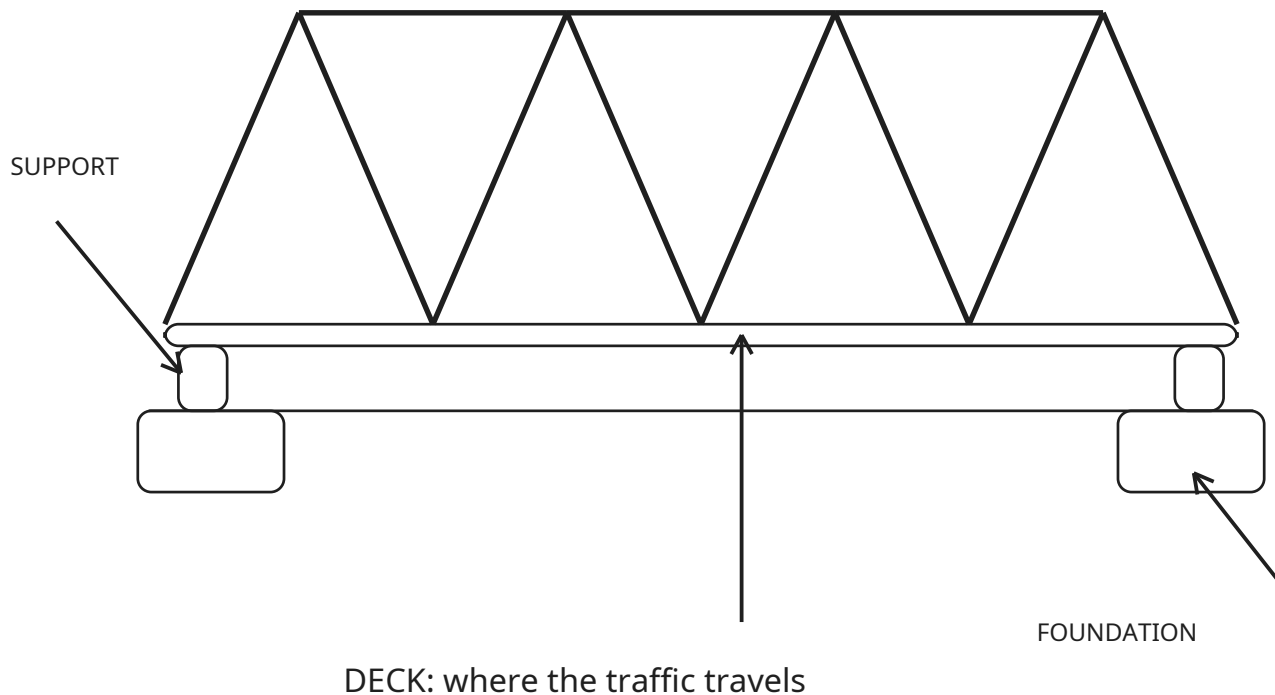
4. _____

Word bank: BEAM / ARCH / TRUSS / SUSPENSION

Look for a straight beam, a curved arch, triangles in a truss, or a deck hanging from cables. These are simplified side views.

Give every part a job

Color the deck with dots, supports with stripes, and foundations with zigzags.



The foundations help spread the loads into the ground. Connect each job to the part you colored:

Carries the capybaras: _____

Holds the deck up: _____

Passes loads into the ground: _____

Use patterns or pencil marks if you do not have colors. The drawing is a learning model, not a construction plan.

Pull or squeeze?

Write T for tension (pulling) or C for compression (squeezing).

A rope in a tug-of-war



A sponge pressed between hands



A hanging bag pulling its strap



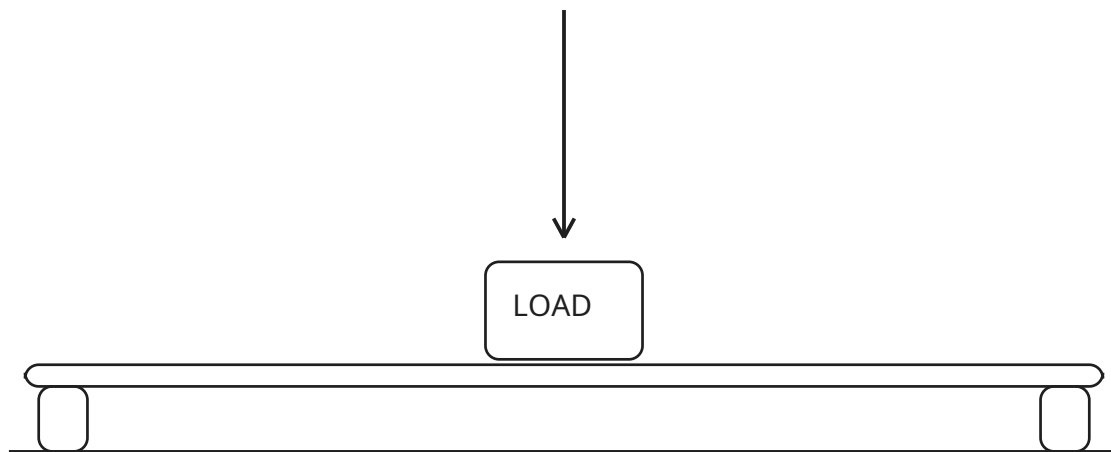
A tower holding up a bridge deck



Gently stretch a strip of paper, then press its ends toward each other. What changed? The same material can be loaded in different ways.

Where does the load go?

Draw arrows from the block down to the ground. Use every box in your route.



The deck passes some load toward each support.

1. DECK

2. LEFT SUPPORT

2. RIGHT SUPPORT

3. GROUND

For a centered load on this symmetric model, both supports help. A load path explains how forces are carried through a structure.

What is the bridge carrying?

Write each item in the best group. Circle one load that can change during the day.

Bridge deck

A visiting bus

Fixed railings

Three cyclists

Permanent towers

A walking capybara

PARTS OF THE BRIDGE

TRAFFIC ON THE BRIDGE

A bridge carries its own weight as well as traffic. Engineers also consider other loads, such as wind; these two groups are only a start.

Make a fair prediction

You will compare the same amount of paper in two shapes. Predict before building.

A / FLAT PAPER



B / FOLDED PAPER



I predict _____ will hold more blocks because ...

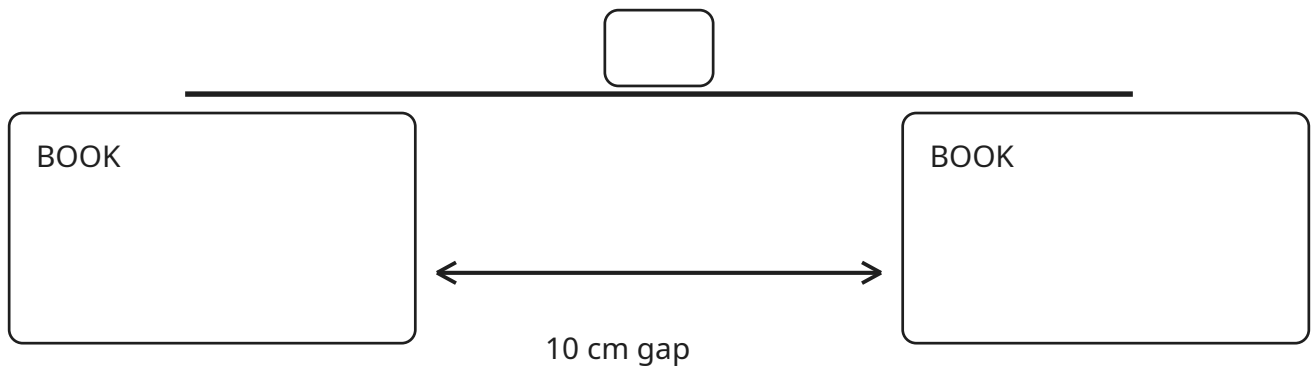
Circle the things that must stay the SAME:

- ☐ Size and type of paper
- ☐ Distance between books
- ☐ Number and size of blocks
- ☐ Where each block is placed

We change the paper shape. Keeping the other conditions alike makes the comparison more useful.

Test A: a flat bridge

Put one sheet across two equal-height books. Set the gap to 10 cm with a ruler.



Lay the sheet with its long edge crossing the gap. Add one identical large block at a time at the center. Keep each new block centered on the stack. Wait 3 seconds after each addition.

Stop when the paper touches the table, slips off a book, or reaches 10 blocks. Record the last number held for 3 seconds. Zero is a useful result too.

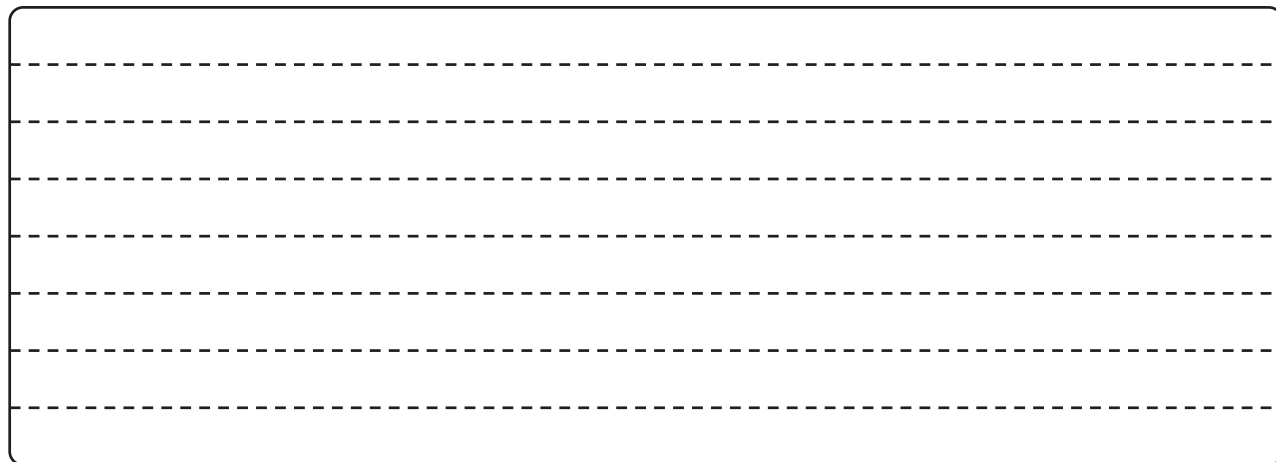
Prediction: ____ blocks

Last held: ____ blocks

Set up on the floor or a low table. A grown-up steadies the books. Use large identical toy blocks; keep the stack low.

Test B: an accordion bridge

Use a fresh sheet of the same size and type. Fold it before repeating the same test.



Fold across the SHORT dimension into 8 equal panels.

Fold in half, then quarters, then eighths. Open it, then alternate mountain and valley folds along the creases like a fan. The long creases must run from one book to the other.



End view: a zigzag

Prediction: ____ blocks

Last held: ____ blocks

Keep the same 10 cm gap, paper amount, blocks, center loading and stopping rule. Folding changes the shape and stiffness, not the paper material.

Make your results visible

Copy your results. Fill one square for each block held. Add a label if you reached the limit.

FLAT

--	--	--	--	--	--	--	--	--	--

FOLDED

--	--	--	--	--	--	--	--	--	--

1 2 3 4 5 6 7 8 9 10

My results show ...

My prediction was / was not supported because ...

A fairer test next time would ...

Reaching 10 means "at least 10," not the maximum possible. Different paper, folding and placement can give different results.

A square that wiggles

Cut seven strips. Tape the ends into one square and one triangle, leaving corners able to bend.

For sturdier strips, glue this part onto scrap card before cutting. Join four strips for a square and three for a triangle. Gently push each sideways.



Tape at the end dots. A grown-up can help.

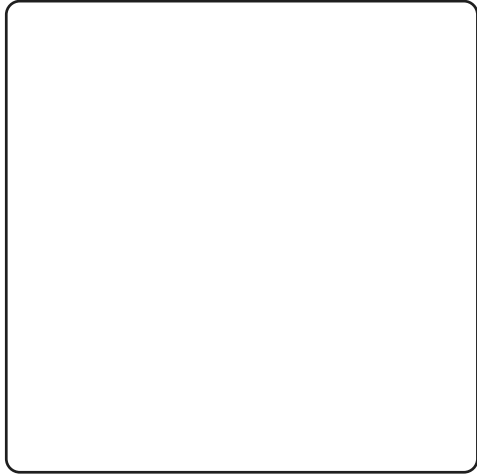
The square changed by ...

The triangle changed by ...

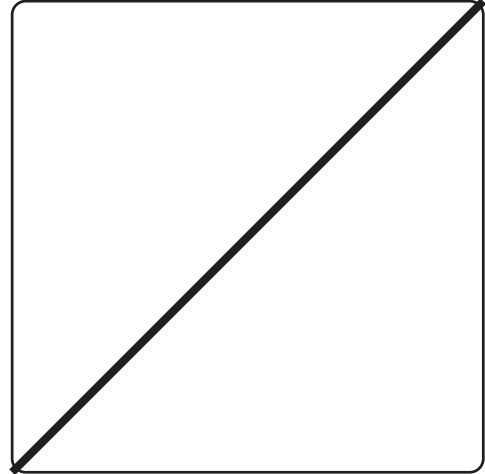
The strips and joints are simplified models. A triangle with fixed side lengths keeps its shape; real strength also depends on materials and connections.

Stop the wobble

Add one diagonal brace to your square from Activity 11. Predict, then push gently again.



BEFORE



AFTER



Cut this brace from scrap card; trim to fit your square.

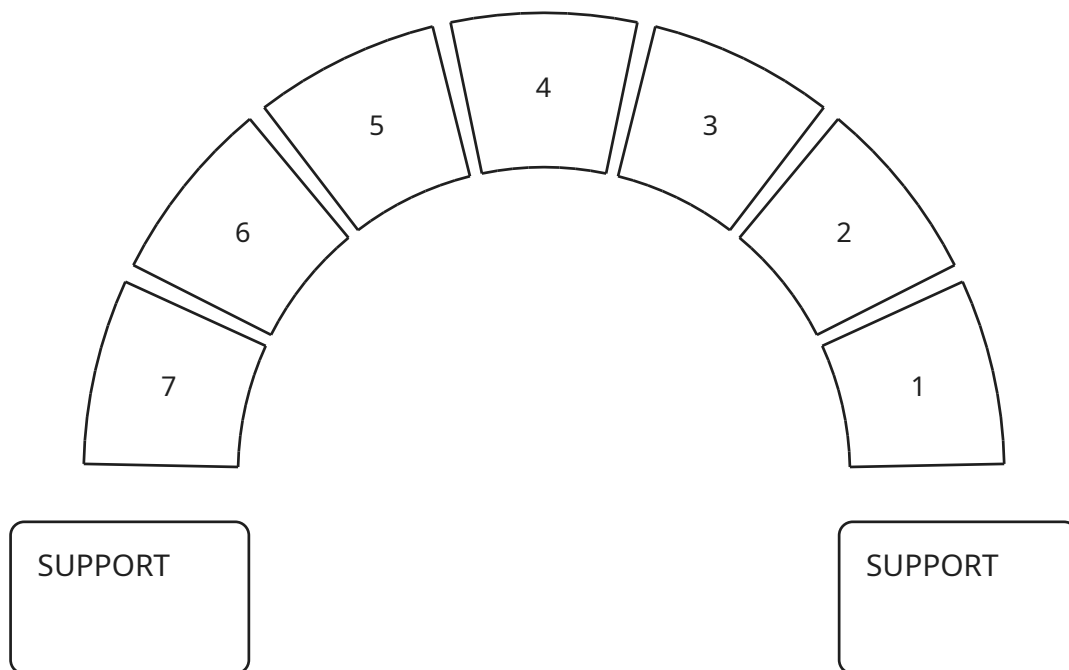
Before testing, I predict ...

With the brace, I noticed ...

Tape the brace to opposite corners. Count the triangles it creates. A brace can stop a hinged square changing into a slanting shape.

The arch puzzle

Cut the seven wedge pieces. Rearrange them as a flat arch on a spare sheet; do not stand them up.



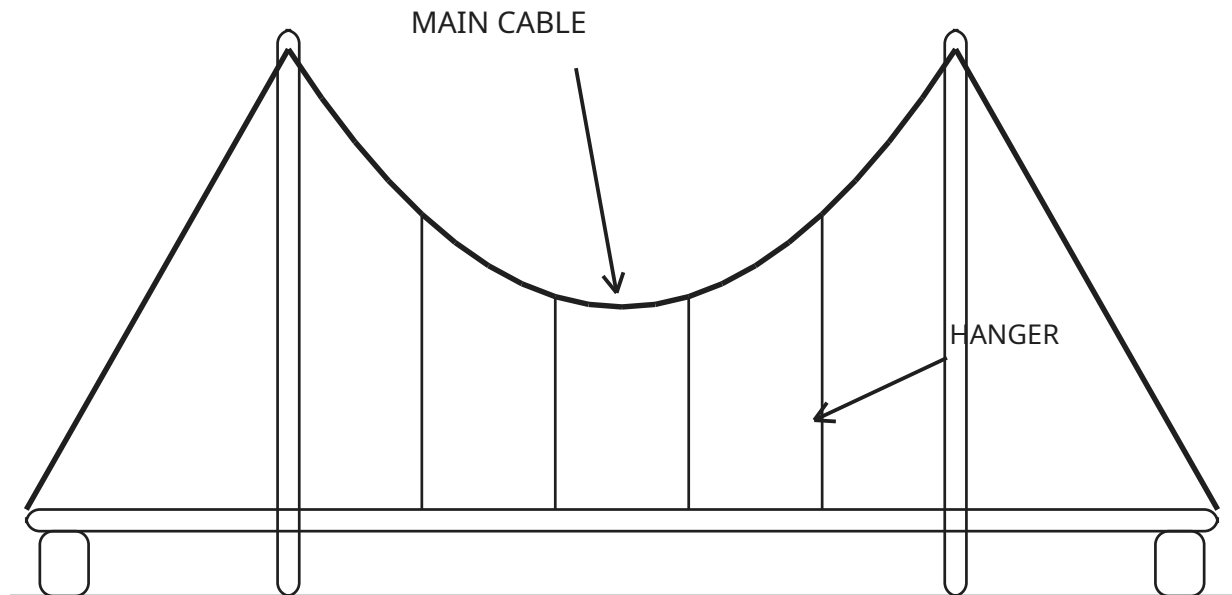
Use a spare sheet as your ground. Put the two support cards under the arch ends. Mark the central wedge K for keystone. Draw arrows pushing outward against the supports.

Why do you think the supports matter?

This is a 2D diagram. A real arch transfers loads through compression and pushes outward at its ends; it needs suitable supports.

Follow the hanging cables

Trace the main cable and hangers with dots. Put stripes on the two towers.



The cable is pulled: tension or compression? _____

The towers are squeezed: tension or compression? _____

The hanging deck pulls on the hangers and main cable. The cable also pushes down on the towers. End anchors and foundations matter too.

Choose for the place

Choose a possible bridge for each imaginary site. Explain one advantage and one thing to check.

A / Garden stream

A short gap, light walkers, few materials.

Choice: _____ Advantage: _____

I would check: _____

B / Busy river

Boats need clear space below; the crossing is wide.

Choice: _____ Advantage: _____

I would check: _____

C / Rocky valley

Firm rock on both sides; a curved shape may fit.

Choice: _____ Advantage: _____

I would check: _____

More than one design can work. Real engineers check span, loads, ground, weather, cost and many other constraints before choosing.

Spend twelve tokens

Plan a parts basket for your own bridge. Stay within 12 tokens. Books and test blocks are free.

PART	COST EACH	QUANTITY	TOTAL
Paper sheet	4	—	—
Tape, 10 cm strip	1	—	—
String, 20 cm	2	—	—

Use at most two sheets of paper. You may cut and fold your paper. Reuse these same parts when you redesign. Add the three totals.

Total spent: ____ / 12

Tokens left: ____

Example: 2 sheets + 4 tape strips cost $8 + 4 = 12$. Your bridge must span a 10 cm gap and try to hold 5 of the same large test blocks.

Draw your first design

Draw a side view and an end view. Label the deck, supports and any folds, braces or cables.

SIDE VIEW / show the 10 cm gap

END VIEW / paper shape

I think this will work because ...

Check your parts basket from Activity 16 before building. Draw the route a load could take from the middle of the deck to the books.

Build it. Test it. Notice.

Build your plan. Use the same 10 cm gap, identical blocks and center loading as before.

Target: hold 5 blocks for 3 seconds. Add one at a time, counting only the last number held. Stop at 10 blocks or if the bridge touches the table or slips off a book.

CHECK	BEFORE TESTING
Parts cost no more than 12	Yes / change needed
Gap is 10 cm	Yes / change needed
Books are the same height	Yes / change needed

Last held: ____ blocks	Target met? YES / NOT YET
------------------------	---------------------------

Where did it bend, slip, twist or stay steady? Sketch or write.

A result that surprises you is useful evidence. This test describes your paper model under these conditions, not the safety of a real bridge.

Change one thing

Choose one feature to improve. Reuse your parts. Keep the test conditions the same.

I will change _____ because I noticed ...

SKETCH THE CHANGE / circle what is different

RESULT	FIRST DESIGN	REVISED DESIGN
Blocks held	_____	_____
Where it bent or slipped	_____	_____

Did the change help? YES / NO / NOT SURE

Changing one feature makes it easier to understand what helped. If both tests hit the 10-block limit, you cannot claim one holds more.

A tiny engineering exhibition

Make a poster for your bridge. Use your actual results so another engineer can learn from you.

My bridge is called:

DRAW YOUR BRIDGE / add arrows and labels

I predicted ...

The test showed ...

I changed ...

My next question is ...

Tell someone how your idea changed. A photograph of the paper bridge plus one surprising result makes a great little science story.

For the grown-up

Keep the investigation playful. Read instructions aloud or let the child explain their answer instead of writing.

A useful four-session path

1: Activities 1-6, notice structures and forces. 2: Activities 7-10, compare paper shapes. 3: Activities 11-16, mechanisms and design decisions. 4: Activities 17-20, build, revise and explain.

Prepare for actual making

Keep the full PDF single-sided. Print pages 12-14 on ordinary paper and glue the cut parts onto scrap card if needed. Have extra paper for bridges, backing and drawing. Single-sided printing protects activities on the back from cutting.

Keep the comparison meaningful

For the flat/folded comparison use identical paper sizes and weights, the same long-edge span orientation, the same 10 cm gap, the same large blocks and the same stopping rule. Accordion creases run along the span. Let the child record a result of zero.

Talk about models

The capybaras are fictional. Diagrams show selected ideas and are not to scale. Hinged shapes explain geometry; paper tests explore stiffness. Neither predicts which full-size bridge is safest. Avoid saying one bridge type is always strongest.

Support and stretch

For younger readers, do the first six activities together and dictate responses. For a stretch, repeat each paper-shape test with fresh paper three times, compare the range, and discuss why the numbers differ.

Editorial prototype: diagrams, answers and PDF layout checked. A parent-and-child playtest is still needed before treating session times or age fit as validated.

Answers and useful questions

Activities 1-10. For observations and designs, discuss evidence instead of looking for one perfect drawing.

1 / The mission

Reach both banks; carry the delivery; leave space for water. Chocolate is a silly distractor.

2 / Bridge names

1 arch, 2 beam, 3 suspension, 4 truss.

3 / The parts

Traffic travels on the deck; supports hold it up; foundations transfer loads into the ground. Patterns can replace colors.

4 / Forces

T, C, T, C, in order. Tension pulls; compression squeezes.

5 / Load path

Load -> deck -> both supports -> ground. Accept split arrows that show both routes.

6 / Loads

Bridge parts: deck, fixed railings, permanent towers. Traffic: visiting bus, cyclists, walking capybara. Any traffic item can change.

7 / Fair prediction

Accept any reasoned prediction. Circle all four: paper, gap, blocks and loading position stay alike. Shape changes.

8-9 / Paper tests

Results vary; never replace them with a predicted number. Record only the last stack held for 3 seconds. Stop at the stated limits.

10 / Comparison

Each filled square represents one held block. A result of 10 means at least 10. If both hit the limit, there is no measured winner.

Ask: "What did you notice?" then "What makes you think that?" Predictions do not need to be right to be useful.

More answers and sources

Activities 11-20. Original activities and artwork; sources support the underlying science.

11-12

A loose-jointed square can shear into a slanted shape. A triangle with fixed sides cannot do that. A diagonal divides a square into two triangles; stronger tape is not the only explanation.

13-14

Wedge 4 is the keystone. Arch ends push outward against their supports. In the simplified suspension bridge, cables and hangers are in tension; towers carry compression.

15

Possible choices: beam for the short stream; suspension for the wide river; arch for the rocky valley. Other justified designs are welcome; site constraints still require checking.

16

Costs must total at most 12 with no more than two sheets. Example: 2 sheets + 4 tape strips = 12. There are several valid baskets.

17-20

Look for a labeled feasible plan, honest test numbers, one clearly described revision, and a poster that reflects observations. If both designs stop at 10, neither is shown to hold more.

Science references

PBS Design Squad: suspension bridge forces and the difference between tension and compression.

pbs.org/video/design-squad-nation-how-does-suspension-bridge-work/

TeachEngineering: Building Our Bridge to Fun! (legacy curriculum, grades 4-6); background on design constraints and comparison tests, not validation of this age band.

teachengineering.org/activities/nyu_bridge_activity1