

EQUIPMENT BUILD PLAN

AIR & WATER PRESSURE

Spool and Card Bernoulli Puzzle

A thread spool, a thumbtack and a playing card make a puzzling little device: blow down through the spool and the card clings to it until you stop. It pairs well with three no-build demonstrations Bruce uses to introduce Bernoulli's principle: paper between two books, a paper strip that lifts when you blow over it, and two hanging bottles that swing together in an air stream.

Written from Bruce's original workshop handout. Bruce's final review of this plan is in progress.

What it shows

Blow hard through a spool and the card underneath refuses to fall off.

Key ideas: Bernoulli's principle, air pressure, fluid flow

Safety (Everyday care). Each person should blow through their own spool and straw. Use the hair dryer on the cool setting. Hang the bottles securely so they cannot fall on anyone.

CONSTRUCTION

Build it

Materials



DIFFICULTY

Beginner

BUILD TIME

5 minutes

COST

Under \$2

SAFETY

Everyday care

GOOD FOR

Teachers, Families

- ☐ **Empty thread spool** · 1
- ☐ **Thumbtack** · 1
- ☐ **Playing card, business card or 3 × 5 index card** · 1
- ☐ **Two books of the same thickness** · 2
Paper-between-books demo
- ☐ **Sheets of paper** · 2
- ☐ **Empty 2 liter bottles** · 2
Hanging-bottle demo
- ☐ **String** · 2 lengths
- ☐ **Water** · about 1 cup per bottle
Adds weight to the hanging bottles

Tools

Drinking straws

Hair dryer with cool setting or a shop vac on exhaust (bottle demo)

1

Gather the parts

You need an empty thread spool, a thumbtack, and a playing card, business card or index card.



2

Pin the card

Push the thumbtack through the center of the card. The point sticks up on one side.

3

Line it up with the spool

Hold the card against the bottom of the spool with the tack point inside the spool's center hole. The tack keeps the card from sliding sideways.

4

Blow and let go

Blow steadily down through the top of the spool and let go of the card. It stays pressed against the spool as long as you keep blowing, and drops the moment you stop.

5

Demo: paper between two books

Lay two books on a table about 4 inches apart and set a sheet of paper across them like a bridge. Ask students to predict what happens when they blow under the paper with a straw. Most expect it to rise; it sags down instead.

6

Demo: blow over a paper strip

Hold a sheet of paper by one edge just below your lower lip so it droops. Blow across the top surface and the paper rises.

7

Demo: hanging bottles

Put about a cup of water in each of two 2 liter bottles and hang them side by side from strings a few inches apart. Blow a stream of air between them with a shop vac on exhaust or a hair dryer on cool, and the bottles move together.

THE PHYSICS**How it works**

Bernoulli's principle says that where a fluid such as air flows faster, its pressure is lower. Air that is not moving pushes harder than air that is moving quickly across a surface.

In the spool, the air you blow has to escape sideways through the thin gap between the spool and the card, spreading out in all directions at high speed. The pressure in that gap is lower than the still air under the card, so the outside air pushes the card up against the spool. When you stop blowing, the pressures even out and gravity wins.

Under the paper bridge and between the hanging bottles, the same thing happens: the moving air stream has lower pressure, so the

Using it

- Always ask for predictions first; these demos work best when the result surprises students.
- Challenge students to blow the card off the spool. The harder they blow, the tighter it holds.
- Ask students to explain the paper bridge in terms of where the air is moving and where it is still.
- Connect the hanging bottles to why two passing trucks or ships are drawn toward each other.

still air on the other side pushes the paper down or the bottles together.

The lifting paper strip is often explained with Bernoulli too, but the air stream also follows the curved surface of the paper (the Coanda effect), so it is a good one to discuss rather than treat as a simple proof.

- Follow up with the straw atomizer, which uses the same low pressure to lift water up a straw.

GO FURTHER

Variations

- Try a ping pong ball held in an upside-down funnel while blowing through it.
- Use different card sizes and weights on the spool and see which is easiest to hold up.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The card falls right away.

TRY THIS

Make sure the tack point is inside the spool hole so the card stays centered, and start blowing before you let go.

IF THIS HAPPENS

The bottles swing apart instead of together.

TRY THIS

Aim the air stream straight down the gap between them, not at either bottle.