

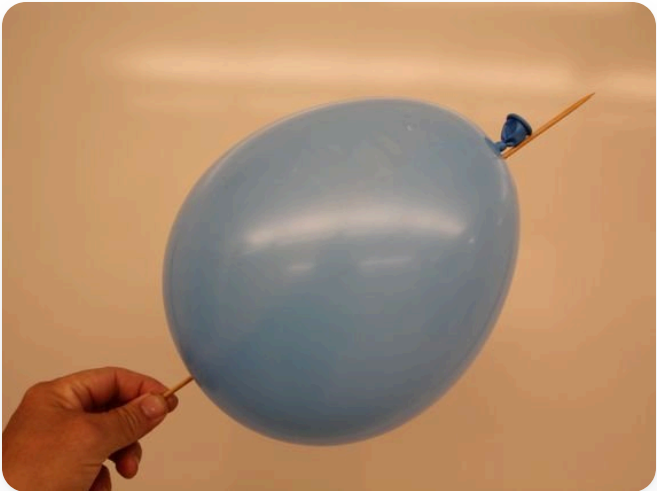
EQUIPMENT BUILD PLAN

MATTER

Poke a Polymer

With a sharp, smooth point and a little dish soap, you can push a skewer through a balloon or pencils through a bag of water, and the plastic seals itself around them. Paper bags, foil chip bags and milk jugs fail the same test. Bruce scaled it from a party trick up to a 20-gallon bag, and the contrast between materials opens a discussion of how polymer molecules are arranged.

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



DIFFICULTY	BUILD TIME
Beginner	15 minutes
COST	SAFETY
Under \$5	Everyday care
GOOD FOR	
Teachers, Families	

What it shows

Slide a sharp stick right through a balloon, or a dozen pencils through a bag of water, and nothing pops or leaks.

Key ideas: polymers, elasticity, molecular structure, properties of materials

Safety (Everyday care). Sharpened skewers and dowels are sharp: point them away from faces and never toward anyone. Check for latex allergies before using balloons, and keep balloon pieces away from young children. Work over a sink or outdoors and wipe up spills so no one slips. For large water bags, hang them from a solid support, never directly over anyone.

CONSTRUCTION

Build it

Materials

- ☐ **Wooden kebab skewers or 1/8 in dowels** · several
Sharpened and sanded smooth
- ☐ **Round pencils, sharpened** · 5-6
Round works better than six-sided
- ☐ **Balloons** · several
Save the deflated ones for balloon-repair experiments
- ☐ **Water balloons** · 2-3
- ☐ **Gallon zip-top freezer bag** · 1-2
- ☐ **Plastic grocery bag without holes** · 1
Many leak to begin with
- ☐ **Dish soap** · a few drops
- ☐ **For comparison: paper bags, a microwave popcorn bag, a foil chip bag, a cereal box** · 1 each
Optional

Tools

Pencil sharpener or knife (adult) for points

Fine sandpaper

Sink, tub or outdoor area

1

Sharpen and smooth the points

Make the skewer or pencil points as sharp as possible, then sand away any rough spots. A smooth point slides between the polymer chains; a rough one tears.

2

Soap the skewer

Wet the skewer and rub a little dish soap on it so it slides easily.



3

Enter at the thick end

Inflate a balloon. Holding it gently, twist and push the skewer very slowly into the darker, thicker spot opposite the knot.



4

Exit by the knot

Keep twisting gently and bring the point out through the thick area right beside the knot. The balloon stays inflated.



5

Try a water balloon

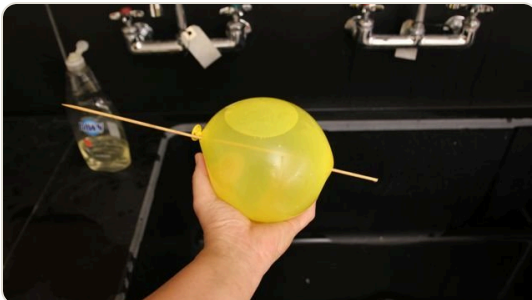
Fill a water balloon about half full and, over a sink, push a very sharp soapy skewer in. It goes halfway in with no leak.



6

Go all the way through

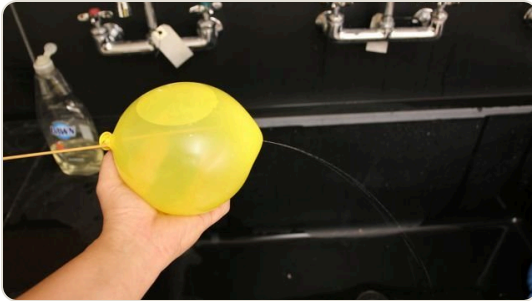
Push the skewer out the other side. Still no leaks.



7

Pull it out

Withdraw the skewer halfway and a stream spurts out; pull it all the way out and you get two streams.



8

Pencils through a bag of water

Fill a gallon freezer bag with water and hold it up. Push soapy round pencils through it one at a time, five or six in all.



9

Watch for leaks

The bag does not leak while the pencils are in place. It only leaks when they are pulled out.



10

Test materials that fail

Try the same thing with a paper bag, a microwave popcorn bag or a foil chip bag. They leak around the stick right away.



11

Skewer a cereal box

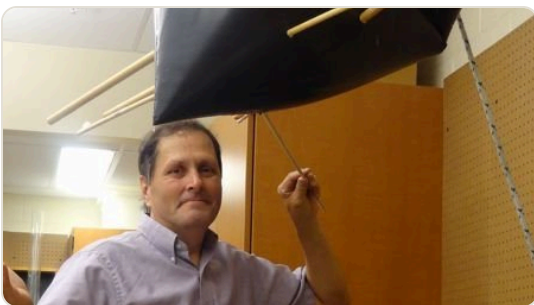
Cardboard boxes will not hold water, so push a skewer through a full box of flake cereal instead. Nothing spills out around the skewer.



12

Go bigger

Fill a heavy-duty trash bag with water, hang it from a solid support near a sink, and push in sharpened, sanded, soaped dowels. Thicker bags work better.

**THE PHYSICS****How it works**

Plastic bags and balloons are made of polymers: giant molecules built from thousands of small repeating units (monomers) linked into long chains. Polyethylene, the

Using it

- Hold the bag of water over a volunteer's head while you add the

plastic in most bags, is made from ethylene units, and its long chains are tangled together like a ball of yarn.

When a smooth, sharp point pushes into polyethylene, the tangled chains slide apart and stretch around it instead of breaking. They stay entangled and pull back tightly against the pencil, sealing the hole. When you pull the pencil out, the stretched hole is left slightly smaller than the pencil, but not closed, so water streams out.

Paper is made of cellulose, another polymer built from glucose units, but its chains are straighter and bundled into fibers that do not stretch. The point tears the fibers and leaves a hole as big as the skewer, so water leaks right away. Foil chip bags behave more like paper: the hole tears instead of stretching.

In a balloon, the rubber near the knot and at the opposite end is stretched the least. Those thicker areas can stretch further around the skewer without tearing, which is why you enter and exit there.

pencils (with their permission).

- Have students predict which bags will leak before testing paper, plastic and foil, then explain the results.
- Compare the holes left in a paper bag and a plastic bag after the skewer is removed.
- Ask why the cereal stays in the box even though the cardboard tore.
- Save the skewered balloons for an experiment on patching balloons.

GO FURTHER

Variations

- Super-size it: Bruce folded a heavy plastic mattress bag (folded to avoid leaky seams) between two 2×4s clamped together, filled it with about 20 gallons of cold water (about 160 pounds), hung it outdoors from a solid support, and skewered it with dowels, tiki torch poles and a broom handle. Heavier sticks can cause leaks, so go carefully.
- Try knitting needles, dowels and pencils of different diameters.
- Try different brands of trash bags; tear-resistant bags may work best.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The balloon pops.

TRY THIS

Use a sharper, smoother, soapier point, inflate the balloon a little less, and enter only at the thick spots, twisting slowly.

IF THIS HAPPENS

The grocery bag leaks before you even start.

TRY THIS

Many thin bags have tiny holes. Use a zip-top freezer bag or test several grocery bags.

IF THIS HAPPENS

Water seeps around the pencils.

TRY THIS

Use round pencils with smooth, soapy surfaces and push slowly.