

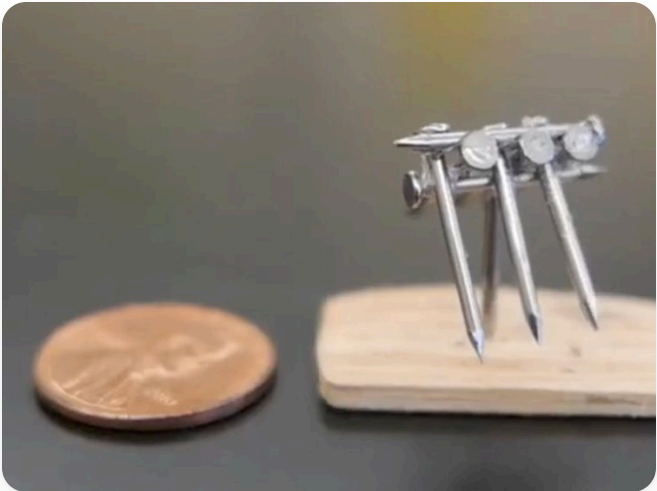
EQUIPMENT BUILD PLAN

MOTION & FORCES

Balancing Nails Challenge

A classic puzzle: stand one nail upright in a block and balance a dozen nails on its head. The secret is an interlocking arrangement that hangs most of its weight below the support. Bruce's extension stacks a second layer to balance 23 nails, and there are tiny-nail and pencil versions for extra challenge.

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
About \$5	Everyday care
GOOD FOR	
Teachers, Families, Makers	

What it shows

Twelve big nails balanced on one nail head looks impossible. Then Bruce doubles it.

Key ideas: center of gravity, balance, stability, torque

Safety (Everyday care). Large nails have sharp points. Work on a table, keep the points away from faces, and have an adult drill the base.

CONSTRUCTION

Build it

Materials

☐ **Eight-inch nails** · 13 (12-nail challenge) or 24 (23-nail challenge)
One extra stands upright as the support

- ☐ **Small wooden block or disk** · 1
Holds the support nail upright
- ☐ **Small nails, about 1 in (optional)** · 13
For the hardest version
- ☐ **Pencils (optional)** · About 12
For the pencil version

Tools

Drill (for the base)

Hammer

1

Make the stand

Drill a hole in a wooden block or disk and set one nail upright in it, head up. This is the support.



2

Lay the first nail

Lay one nail flat on the table. This will be the bottom spine.

3

Add ten crossing nails

Lay ten nails across the spine, alternating directions so their heads hook over the spine on alternate sides and their shanks slope down to the table.



4

Lock with the top nail

Lay one more nail on top, parallel to the spine, in the notch formed where the crossing nails rise up. That makes 12.

5

Lift and balance

Pinch the ends of the top and bottom nails together and lift the whole bundle. The crossing nails swing down into a hanging V. Rest the middle of the bottom spine on the head of the support nail.

6

Go for 23

Build the 12-nail bundle on the table. Lay a second set of ten nails across the top nail, again alternating directions, and finish with one more nail on top.



7

Lift the double bundle

Squeeze the top nail and the bottom spine together to hold everything as you lift, then set the bottom spine on the support nail. That is 23 nails on one.

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

An object balanced on a point is stable when its center of gravity is directly below the support. If it tips a little, gravity's pull on the low center of gravity swings it back, like a hanging weight.

Using it

- Hand out the nails and the stand and let students try before showing the arrangement.

When you lift the bundle, the crossing nails hang down on both sides of the spine, so most of their weight ends up below the head of the support nail. The top nail presses down on the crossing nails and locks them against the spine, so the whole bundle acts as one rigid object.

In the 23-nail version the second layer sits higher, but it is locked into the same rigid bundle, and the hanging nails keep the combined center of gravity low enough to stay balanced.

- Once they succeed, challenge them to balance more nails.
- Ask students to sketch where they think the center of gravity is.
- Try the smallest nails you can find; Bruce found 1 in nails the hardest of all.
- Try pencils. There is an easy trick that makes them work; see the video.

GO FURTHER

Variations

- Tiny-nail version with 1 in nails on a small block.
- Pencil version.
- Balancing toys that use the same low-center-of-gravity idea.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The bundle falls apart when lifted

TRY THIS

Squeeze the top nail and bottom spine firmly together, and lift slowly.

IF THIS HAPPENS

It tips off the support

TRY THIS

Rest the exact middle of the spine on the support head, and make sure the crossing nails alternate evenly side to side.

IF THIS HAPPENS

Nails slide along the spine

TRY THIS

Make sure each crossing nail's head hooks over the spine.

and supervise children.