

EQUIPMENT BUILD PLAN

MOTION & FORCES

Dynamics Carts and Crashing Blocks

Two wooden carts cut from a 2 × 4 carry a spring-loaded dowel plunger. Pressed together and released, they push each other apart, showing that forces come in equal and opposite pairs. A simpler wheel-free version joins two blocks with a long rubber band so they race toward each other and meet in the middle. Stack extra blocks on either one to explore how mass affects acceleration, or leave a block loose on top to demonstrate inertia.

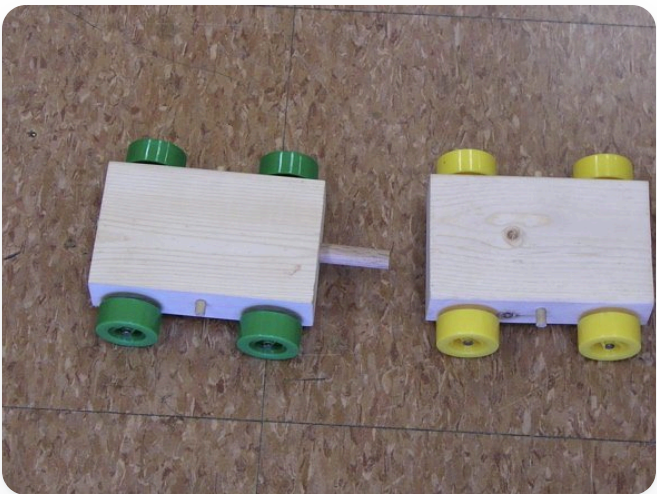
Written from Bruce's original workshop handout. Bruce's final review of this plan is in progress.

What it shows

Release two carts pressed together and they shoot apart at the same speed; triple the mass of one and it moves only a third as fast.

Key ideas: Newton's third law, Newton's second law, inertia, momentum, mass and acceleration

Safety (Adult build / supervision). An adult should do the sawing and drilling; clamp blocks or hold them with a leather glove while drilling. Stretched



DIFFICULTY	BUILD TIME
Intermediate	2-3 hours
COST	SAFETY
About \$10	Adult build / supervision
GOOD FOR	
Teachers, Makers, Families	

rubber bands can snap, so keep faces away and do not overstretch them.

CONSTRUCTION

Build it

Materials

- ☐ **Pine 2 × 4** · About 3 ft
Cut into 6 in blocks: 2 per pair, plus extras for adding mass
- ☐ **Wooden dowel, 1/2 in** · About 6 in
The plunger
- ☐ **Wooden dowel, 1/4 in** · About 1 ft
Short pegs in the block sides for rubber bands
- ☐ **Compression spring** · 1
Fits loosely inside a 1/2 in hole; from a hardware store
- ☐ **Small screw eye** · 1
For the end of the plunger
- ☐ **String** · About 1 ft
- ☐ **Plastic wheels (craft or hobby shop)** · 8
For two carts
- ☐ **Nails for axles** · 8
Sized to fit the wheel holes
- ☐ **Open screw hooks (cup hooks)** · 2
For the rubber-band blocks
- ☐ **Long rubber band** · 1-2
- ☐ **Rubber bands** · Several
To strap extra blocks on top
- ☐ **Meterstick** · 1

Tools

Saw

Drill with 1/2 in, 1/4 in and 1/8 in bits, plus a bit for the nail axles and a larger bit for the eyelet recess

Hammer

Ruler and pencil

Sandpaper

Thin wire (to fish string through a hole)

1

Cut and mark the blocks

Cut the 2 × 4 into 6 in blocks. On one end of a cart block, draw diagonals from corner to corner to find the center.



2

Drill the plunger hole

Drill a 1/2 in hole at the center mark, as deep as the bit allows; a deeper hole keeps the plunger straighter. Sand the hole or the dowel until the dowel slides in and out easily.



3

Drill the string hole

From the opposite end, drill a 1/8 in hole straight through to meet the bottom of the 1/2 in hole.

4

Make the plunger

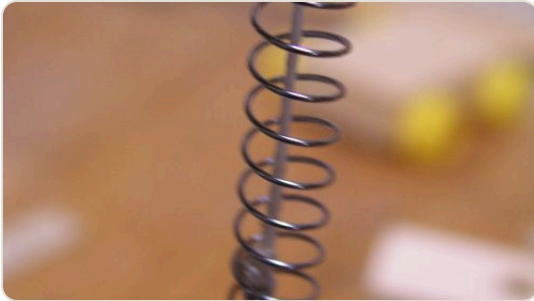
Screw a small screw eye into one end of the 1/2 in dowel. Drop the spring into the hole, push the dowel in on top, mark it flush with the block face, and cut it so it disappears completely into the hole when the spring is compressed.



5

String the plunger

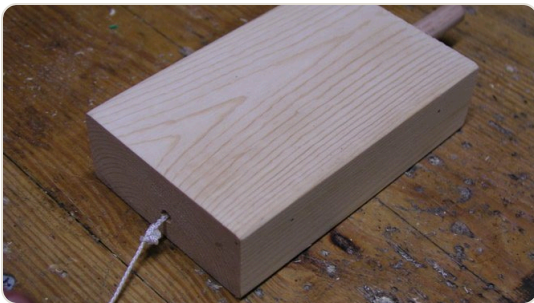
Tie a string to the screw eye and thread it through the spring. Feed the string down the hole and out the 1/8 in hole at the back (a thin wire helps fish it through).



6

Set the plunger travel

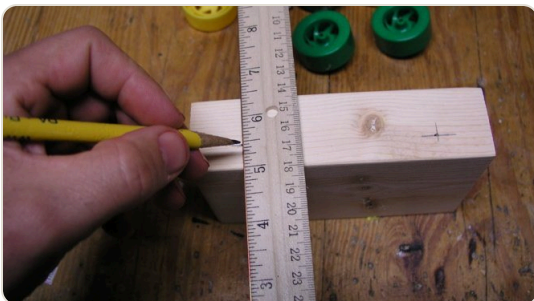
Let the spring push the plunger out to the extension you want, then tie a knot in the string snug against the back of the block. The plunger can now be pushed in but cannot fly out of the hole.



7

Mark and drill the axle holes

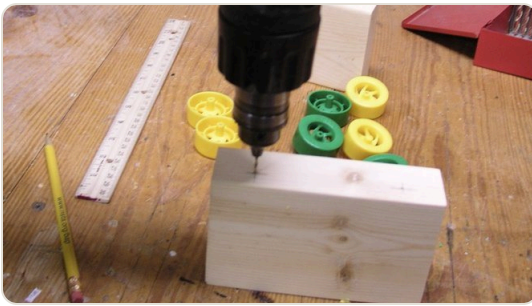
Carefully mark the wheel positions so they are identical on both carts, and drill small pilot holes for the nail axles.



8

Attach the wheels

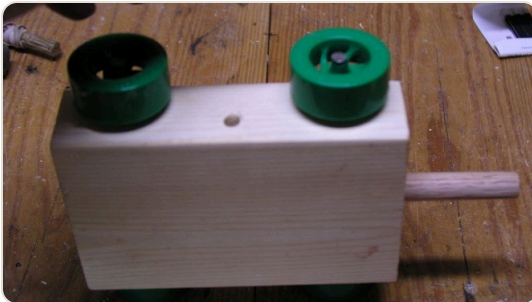
Drive a nail through each wheel into its hole, stopping while the wheel still turns freely.



9

Add the side pegs

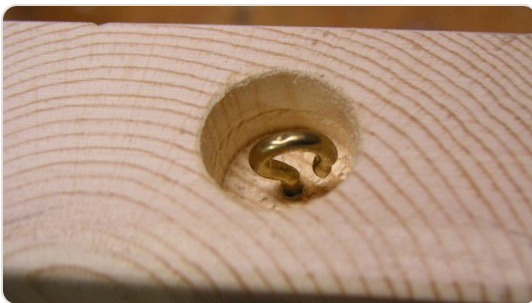
Drill 1/4 in holes in the sides of each cart and glue in short dowel pegs (nails also work). Rubber bands stretched between the pegs hold extra blocks on top.



10

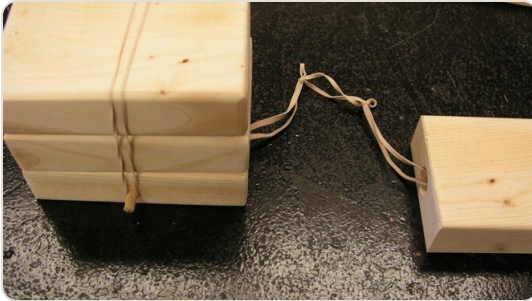
Build the rubber-band blocks

For the wheel-free version, find the center of one end of two more 6 in blocks and drill a shallow recess there. Screw an open hook into each recess, loop the rubber band over it, then tighten the hook so the band is locked in place below the surface.



Peg the blocks

Add short dowel pegs to the sides of these blocks too, so extra blocks can be strapped on.



THE PHYSICS

How it works

When the spring pushes on one cart, it pushes just as hard on the other in the opposite direction: Newton's third law. The forces are equal and act for the same time, so the carts receive equal and opposite pushes.

Newton's second law says acceleration equals force divided by mass. With equal masses, the carts leave at equal speeds. Strap two extra blocks onto one cart (three times the mass) and it moves off at about one-third the speed of the lighter cart, while their momenta (mass times velocity) stay equal and opposite.

The rubber-band blocks show the same law in reverse. The stretched band pulls both blocks equally, so equal blocks meet in the middle; a heavier block accelerates less and the meeting point shifts toward it.

The loose-block trick shows inertia: when the bottom block is yanked away suddenly, friction is too small to accelerate the top block as quickly, so it gets left behind.

Using it

- Press the two carts together so the plunger is fully inside and the blocks touch, then let go. Compare the distances they roll.
- Strap one, two or three extra blocks onto one cart and compare speeds or distances with the mass ratio.
- Rubber-band blocks: lay a meterstick flat, pull the blocks to the 20 cm and 80 cm marks, and release. Equal blocks collide at the 50 cm mark. Add mass to one and predict the new meeting point.
- Inertia: set a loose block on top of one rubber-band block (not strapped), stretch, and release only that block. The bottom block shoots away and the top block is left behind.
- Ask: if I push a book, does it push me back? Why does the book move and not me?

GO FURTHER

Variations

- Bruce shows three variations of these blocks and carts in his video, using the same 6 in block size throughout so the masses are easy to multiply.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The plunger sticks

TRY THIS

Sand the hole with sandpaper wrapped around a pencil, or sand the dowel down slightly.

IF THIS HAPPENS

The carts curve instead of rolling straight

TRY THIS

Check that the wheels are aligned and at identical positions on both carts, and that each turns freely.

IF THIS HAPPENS

The rubber-band blocks do not meet at the center

TRY THIS

Pull them out equal distances, release both at the same instant, and use a smooth surface.

IF THIS HAPPENS

The plunger shoots out

TRY THIS

Retie the knot in the string at the back of the block so it limits the plunger's travel.