

EQUIPMENT BUILD PLAN SOUND & WAVES

Sneaky Pendulums (Coupled Pendulums)

Two equal pendulums hang from a shared, slightly slack support string. Set one swinging and the energy gradually flows through the string into the other, back and forth, until both stop. Bruce starts with a student's sneakers for a laugh, then turns it into a lab where groups test the variables that control resonance.

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

What it shows

Tie two sneakers to a string, swing one, and watch the other slowly steal all its motion, then give it back.

Key ideas: resonance, coupled oscillators, energy transfer, natural frequency, pendulum period

Safety (Everyday care). Anchor the support string to sturdy stands or posts. Do not hang weights from ceiling light fixtures, and never hang people from the setup.

CONSTRUCTION

Build it



DIFFICULTY	BUILD TIME
Beginner	20 minutes
COST	SAFETY
Under \$5	Everyday care
GOOD FOR	
Teachers, Families	

ALSO IN BRUCE'S BOOK

A version of this device appears in *If You Build It, They Will Learn* (NSTA Press).

About the book

Materials

- ☐ **Strong string or cord for the support line** · About 1-2 m
Tied between two stands
- ☐ **A pair of sneakers with laces** · 1 pair
Or two equal weights
- ☐ **Lab version: heavy steel nuts, washers or lead-free sinkers** · Several
- ☐ **String for the pendulums** · Several 30-60 cm pieces
- ☐ **Vertical version: two weights about 10:1 in mass, or an apple and a strawberry** · 1 set
Plus about 1 m of string

Tools

Scissors

Two ring stands with clamps (or two sturdy chairs or posts)

Stopwatch (optional)

1

Tie the support string

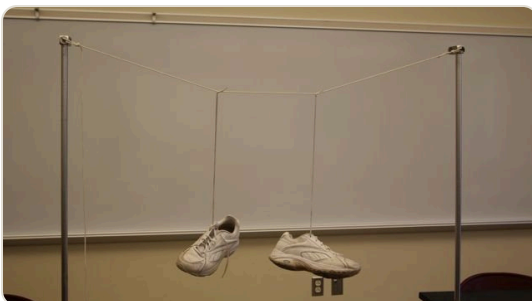
Stretch a string between two clamped stands, chairs or posts. Leave it a little slack; a sagging string couples the pendulums more strongly.



2

Hang two equal pendulums

Tie one sneaker's lace to the support string and the other a short distance away, far enough apart that they cannot collide. Make the two lengths equal.



3

Start one swinging

Pull one sneaker back, perpendicular to the support string, and release it. Leave the other hanging still.

4

Watch the transfer

Over several swings the first sneaker slows and stops while the second builds to a full swing. Then the process reverses.



5

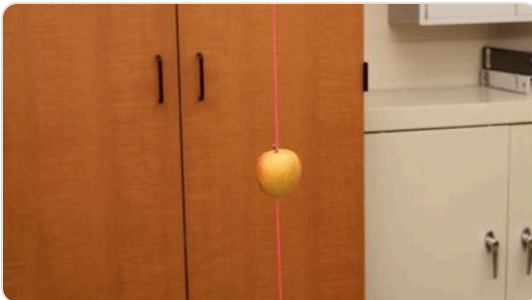
Build the lab version

Replace the sneakers with nuts, washers or sinkers on shorter strings so groups can change one variable at a time.

6

Try a vertical double pendulum

Tie about 18 in of string to a support, then a heavy weight, then another 18 in of string and a much lighter weight (about one-tenth the mass). Pull the bottom weight back and release.

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

Two pendulums of the same length have the same natural frequency. Each time the swinging one moves, it tugs the support string a little, and the string passes that tug to the other pendulum.

Using it

- Have the sneakers' owner try to copy the motion with their own feet: easy when both swing together or

Because the frequencies match, each tug arrives at the right moment to add to the second pendulum's swing, like a well-timed push on a playground swing. Energy steadily flows across until the first pendulum is still. Then the roles reverse and the energy flows back.

If both start together in step, or exactly opposite, there is no back-and-forth exchange: those are the two 'normal modes' of the pair. Starting just one pendulum is a mixture of both modes, and the slow beat between them is what you see as the energy sloshing back and forth.

opposite, nearly impossible during the energy transfer.

- Ask: what will happen if we pull one sneaker back and let go? Collect predictions first.
- Lab variables to test: support-string tightness, heavier or lighter pendulums, unequal masses, pulling both back together, adding more pendulums of the same length, spacing between pendulums, and the length of the support string.
- Barton's pendulums: hang five pendulums of different lengths plus a sixth that matches one of them, and drive with the odd one out. Only its match responds strongly.
- List other examples of resonance from sound, electricity, chemistry and atomic physics.

GO FURTHER

Variations

- Vertical double pendulum with fruit: thread string through an apple and tie it to a strawberry or cherry stem below.
- Hang a pendulum from the bottom of a second, heavier pendulum of about the same length (for example, a weight hanging from a bar that itself swings on cords) and watch the energy pass between them.
- Use fun bobs: Bruce has used apples, bananas and all sorts of everyday objects.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The energy barely transfers

TRY THIS

Make the two lengths exactly equal and loosen the support string a little for stronger coupling.

IF THIS HAPPENS

Transfer happens too fast to see

TRY THIS

Tighten the support string or spread the pendulums farther apart.

IF THIS HAPPENS

Pendulums twist and wobble

TRY THIS

Pull straight back, perpendicular to the support string, and release gently.

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