

EQUIPMENT BUILD PLAN

MOTION & FORCES

Falling Weight and Wrap-Around Stopper

A heavy weight and a light weight hang on one string looped over a bar. When the light one is released, the heavy one falls, the light one spirals around the bar faster and faster, and the wraps of string grip the bar and stop the fall. It packs energy, circular motion and friction into a cheap, surprising demo that also makes a strong student inquiry.

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

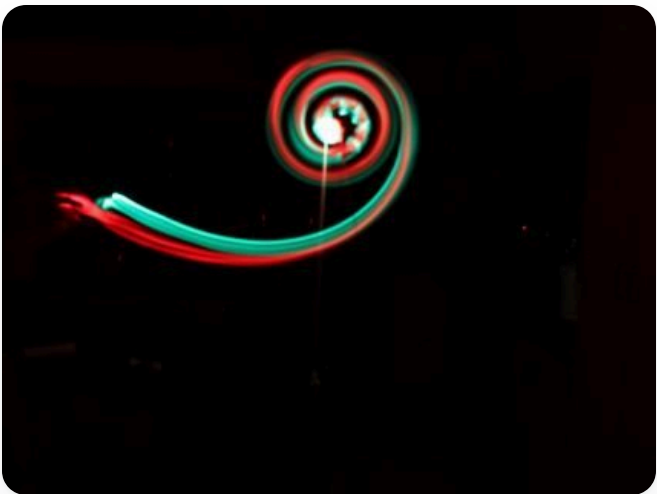
What it shows

Let go of a tiny weight and it whips around a bar so fast it catches a weight fourteen times heavier before it hits the table.

Key ideas: centripetal force, friction, potential and kinetic energy, circular motion, spirals

Safety (Everyday care). The light weight moves fast and can swing wide; stand to the side and keep faces back. Don't use glass objects, and pad the table while you find the right weight ratio and string length.

CONSTRUCTION



<div>DIFFICULTY</div> <div>Beginner</div>	<div>BUILD TIME</div> <div>15 minutes (washer version)</div>
<div>COST</div> <div>About \$3</div>	<div>SAFETY</div> <div>Everyday care</div>
<div>GOOD FOR</div> <div>Teachers, Families, Makers</div>	

Build it

Materials

- ☐ **Steel washers or nuts, all the same size** · 15
14 for the heavy weight, 1 for the light weight
- ☐ **String** · 1 m
Bruce uses a bright, smooth braided string
- ☐ **A smooth horizontal bar about table height or higher** · 1
A lab-stand rod, broom handle or pipe clamped between supports; even a finger works
- ☐ **Small LED lights (battery 'micro lights') and tape** · 2
Optional, for long-exposure photos

Tools

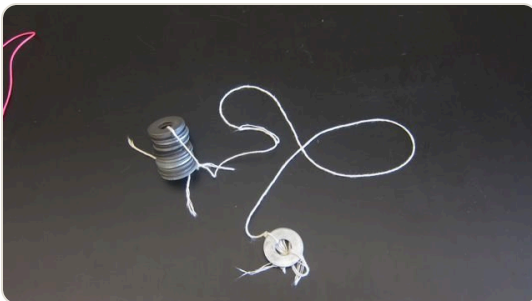
Scissors

Kitchen scale (optional)

1

Tie on the weights

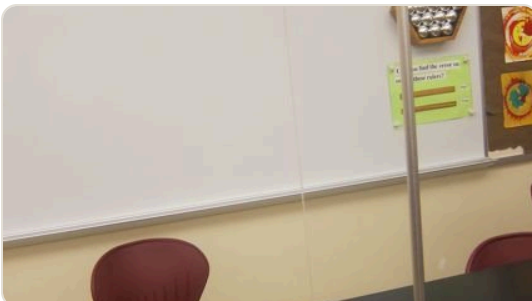
Tie 14 washers together on one end of a 1 m string and a single washer on the other end. Bruce finds the heavy weight works best at about 14 times the light one.



2

Set up the support

Clamp a smooth bar level, with enough clear space below it for the heavy weight to fall freely.



3

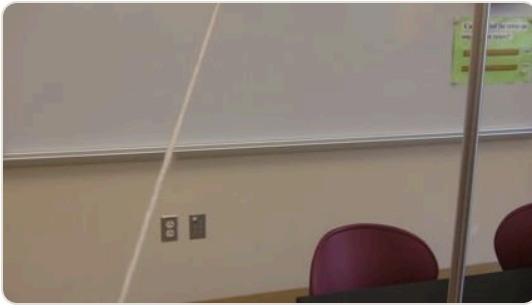
Hang it over the bar

Loop the string over the bar. Hold the single washer so the heavy stack hangs just below the bar.

4

Pull back and release

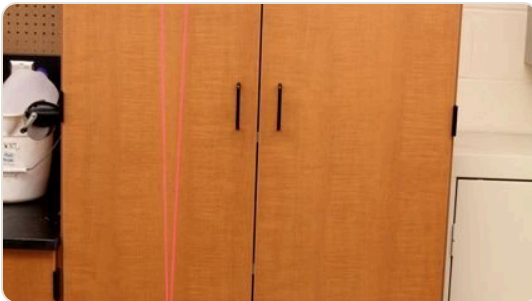
Pull the light washer out to the side, about 60 degrees from vertical, with the string straight. Let go, like releasing a pendulum.



5

Watch the wrap

The heavy stack drops while the light washer swings up and around the bar, wrapping the string tighter and tighter. The wraps grab the bar and stop the heavy stack, often 3-5 turns, and usually well before it reaches the table.



6

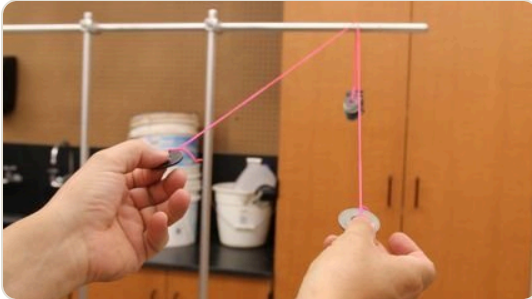
Adjust

If the heavy weight hits the table, add a little weight to the light end or release from a different angle or height; if the light weight cannot wrap all the way around, make it lighter. Record what works.

7

Try two light weights

Tie 28 washers on one string and a single washer on each of two separate strings, and loop them all over the bar. Released together they act much like one light weight; released from opposite sides, they can wrap in opposite directions (keep them small so they do not collide).



8

Photograph the path (optional)

Tape a small LED to each weight, darken the room, set a camera to a 3-5 second exposure, and release. The light weight draws a spiral closing in on the bar.



THE PHYSICS

How it works

As the heavy weight falls, it pulls string over the bar and drags the light weight toward the bar. The string's pull, plus the bar it presses against, keeps bending the light weight's path into a curve: that pull toward the center is a centripetal force.

The light weight's swing gets shorter as string wraps onto the bar, so its path is a spiral closing in on the support. Its speed stays roughly the same while the radius shrinks, so it goes around faster and faster, which looks a lot like a spinning skater pulling in their arms.

Using it

- Inquiry: What weight ratio works best? What is the smallest and largest release angle that still works?
- Does string length matter? Try a very short string and a very long one.
- Challenge: adjust the variables to stop the heavy weight as close to

Each wrap rubs against the bar and against the string already there. Friction from a rope wrapped around a post grows very quickly with each extra turn (sailors use this to hold big loads with a few wraps around a post), so after a few turns the grip is enough to stop the heavy weight.

The ratio matters. If the light weight is too light, it cannot make enough wraps to stop the fall. If it is too heavy, it swings too slowly to get all the way around the bar.

the table as possible without touching.

- Trace the energy: potential energy of the raised weight becomes motion, and friction at the bar finally turns it into heat.
- Try other objects with a big-small pair, such as an apple tied by its stem against a single grape.

GO FURTHER

Variations

- Make a pair of flat wooden figures as a 'story' version: a large character that falls and a small object that saves it, cut from 1/2 in wood, with a small screw eye in each and a printed or painted picture varnished on. Draw your own designs, or have students design pairs (a frog and a fly, a piano and its stool, a big fish and a dragonfly). Weigh them and sand the small one until the ratio is near 14 to 1.
- The classic version of this demo uses a wineglass and a napkin ring; Bruce does not recommend glass.
- Use blinking LEDs for the long-exposure photo to see how the speed changes along the path.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The heavy weight hits the table.

TRY THIS

Raise the bar, release from a wider angle, or make the light weight a little heavier so it grips sooner.

IF THIS HAPPENS

The string wraps a few turns then unwinds.

TRY THIS

The light weight is too light; add a washer or reduce the heavy stack.

IF THIS HAPPENS

The light weight will not go all the way around.

TRY THIS

It is too heavy for the heavy stack; remove some weight from the light end.

IF THIS HAPPENS

The light weight hits the heavy one.

TRY THIS

It happens sometimes; release slightly to one side and practice your release angle.

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