SHIFTING RHYTHMS

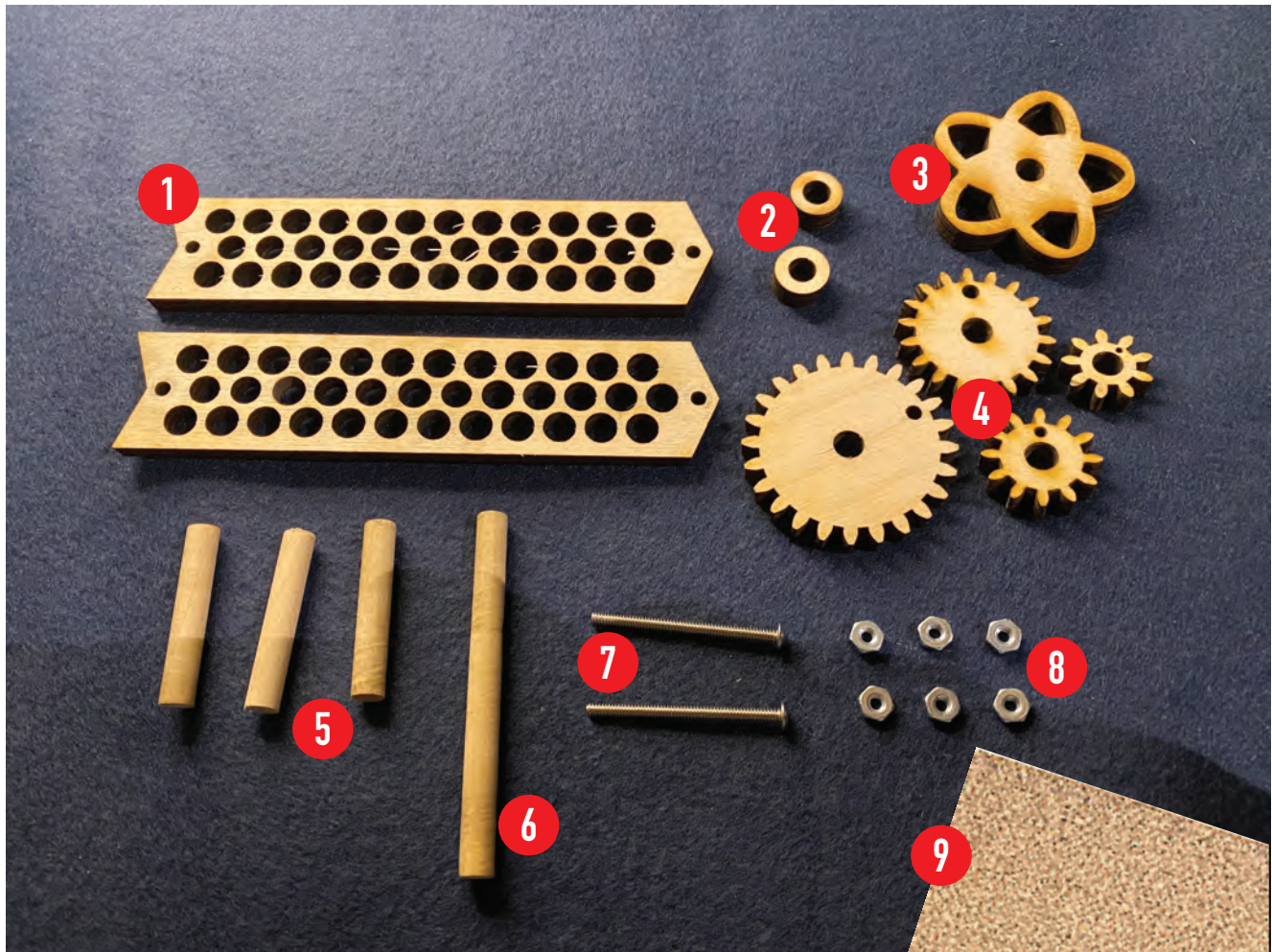# GEAR BOX SPINNER

Time Estimate: 90 minutes

Tags: Mechanical

# Part 1: Materials and Tools

To build your gearbox, you'll need:

1. Outer frame (x2)
2. Spacers (2)
3. Star spinner
4. Gears (4 sizes)
5. Short pegs (x3)
6. Long peg
7. Screws (x6)
8. Nuts (x6)
9. Sandpaper

Part 2: What is a Gearbox?

A gearbox is a set of gears held together so that they move and connect with each other in a certain way. They often have lots of gears of many different shapes and sizes, but the goal is usually the same: put power in one end, and get power out the other end.
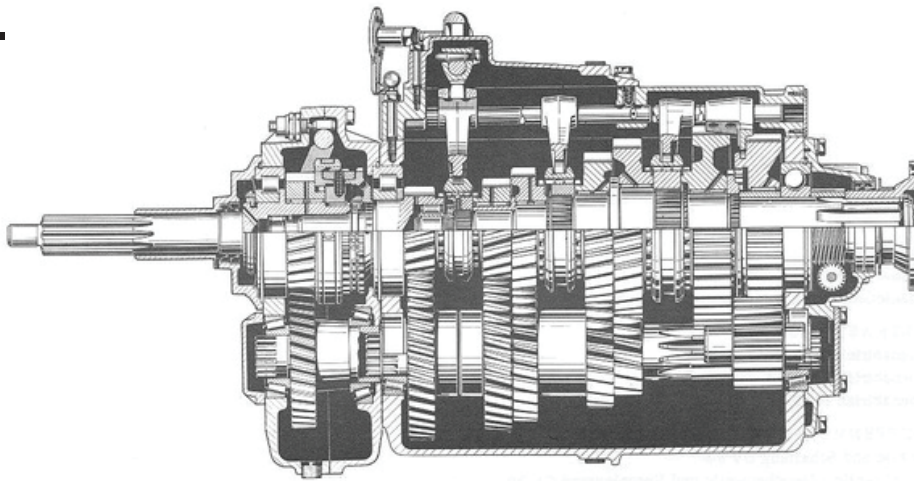
The gears can help us make that power more useable by speeding it up, slowing it down, or even changing directions. The gearboxes you see here are ones made for cars. Ours will be a little bit simpler.

Part 3: Testing Our Gears

The first step is to prepare our pegs. We need to make part of the pegs flat so that they fit onto our gears. Slide the pegs back and forth across the sandpaper until they just barely have a small flat edge, like this shape: ●


Check to make sure the pegs fit into the holes on the gears. If it's still too tight, sand down the flat edge a little more until it fits. Make sure all your pegs fit tightly before you continue.

Part 3: Testing Our Gears
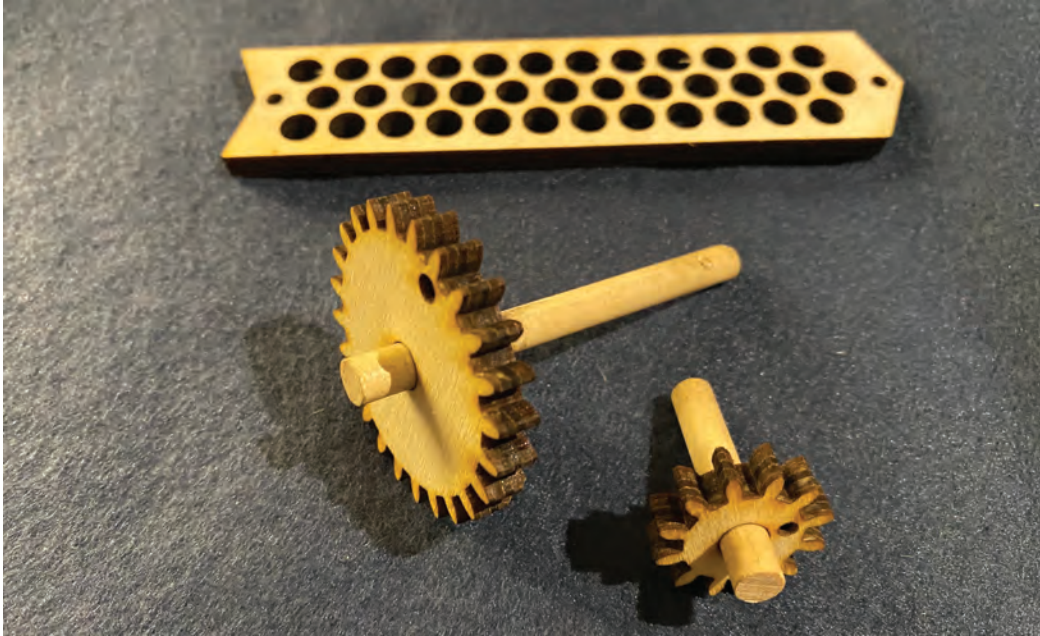
Grab the biggest gear and the second-smallest gear. Put the long peg through the big gear and one of the short pegs through the small gear. These pegs will be our gear's *axles*. Leave a little bit of the peg still poking through the end.
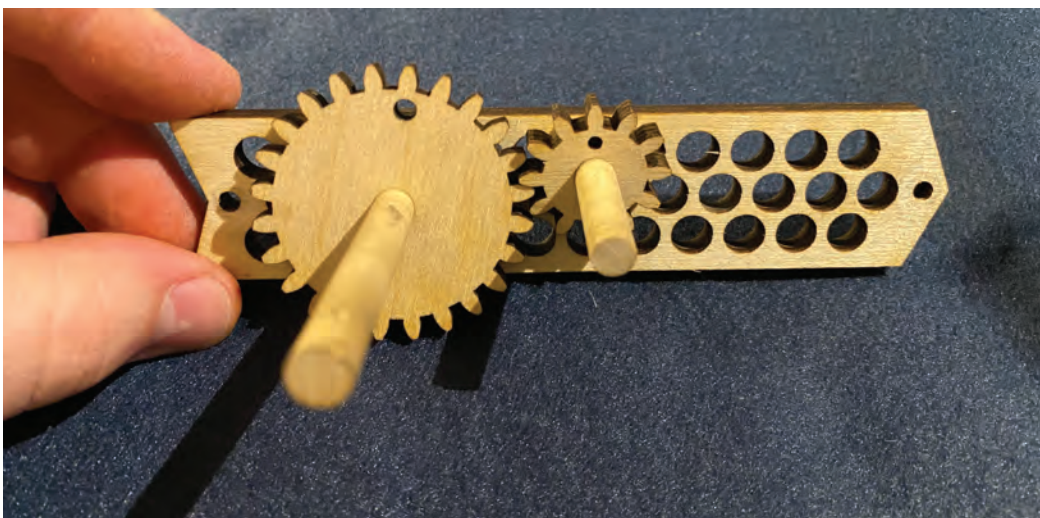

Put the pegs into the frame so that the gears' teeth interlock. Try to get it so that the tiny hole on each gear is pointing upwards.

Part 3: Testing Our Gears
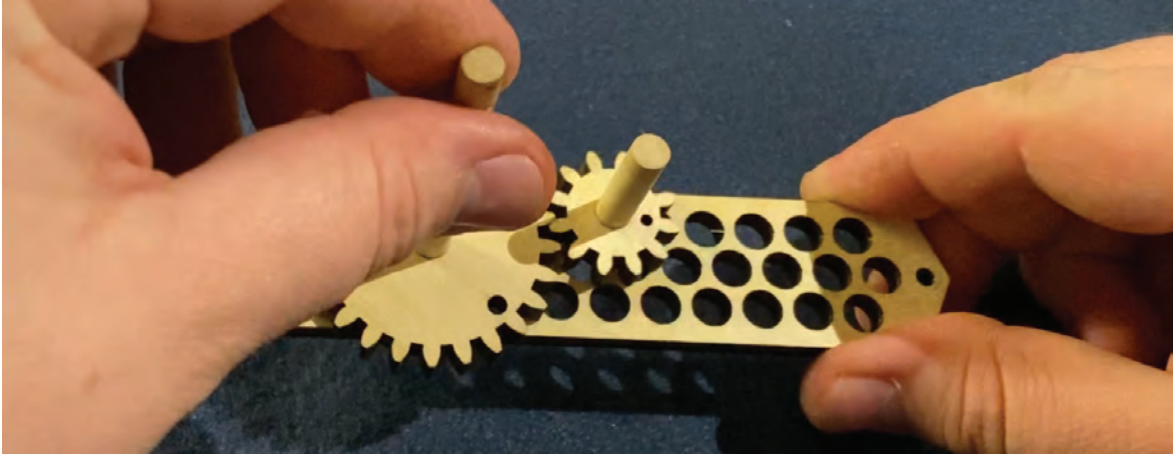
Spin the big gear and watch the small gear. Now, spin the small gear and watch the big gear. Which order makes the other gear spin faster—big to small, or small to big?

How many times do you have to spin the small gear for the big gear to make a full turn?
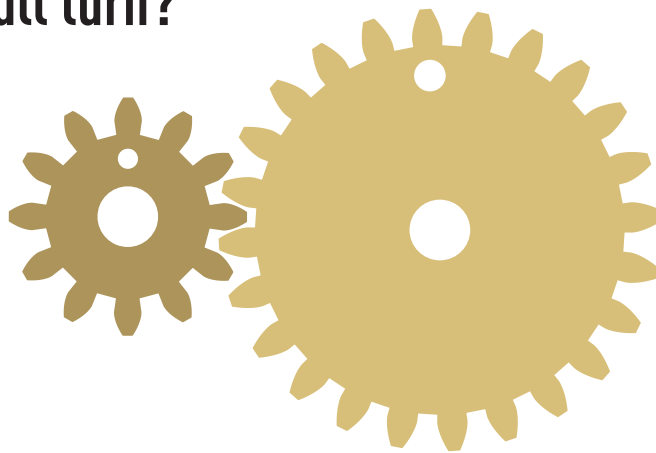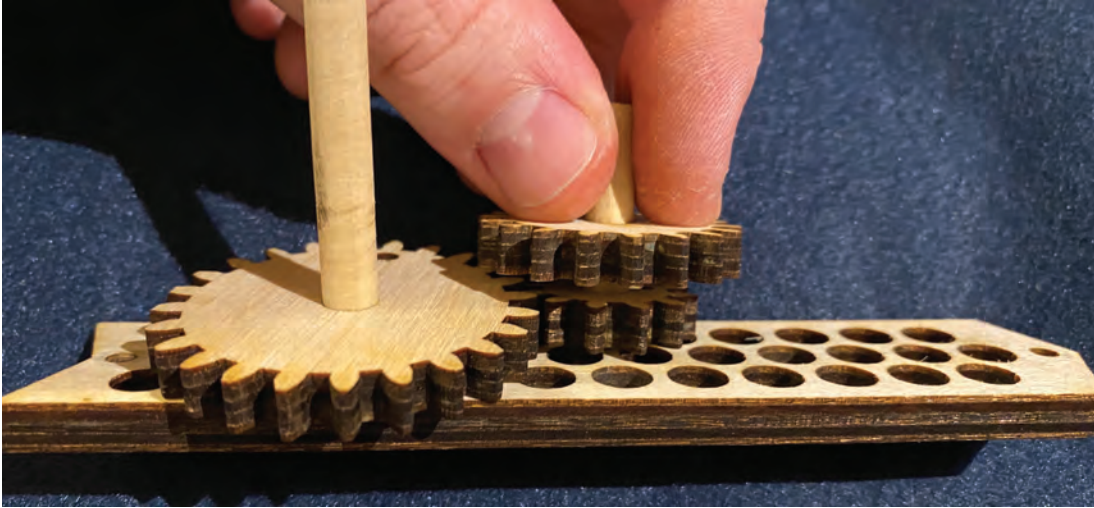

Count the number of teeth on the big gear: _____ teeth
Count the number of teeth on the small gear: _____ teeth

What is the big gear number divided by the small gear number? _____

What do you think this means? _____
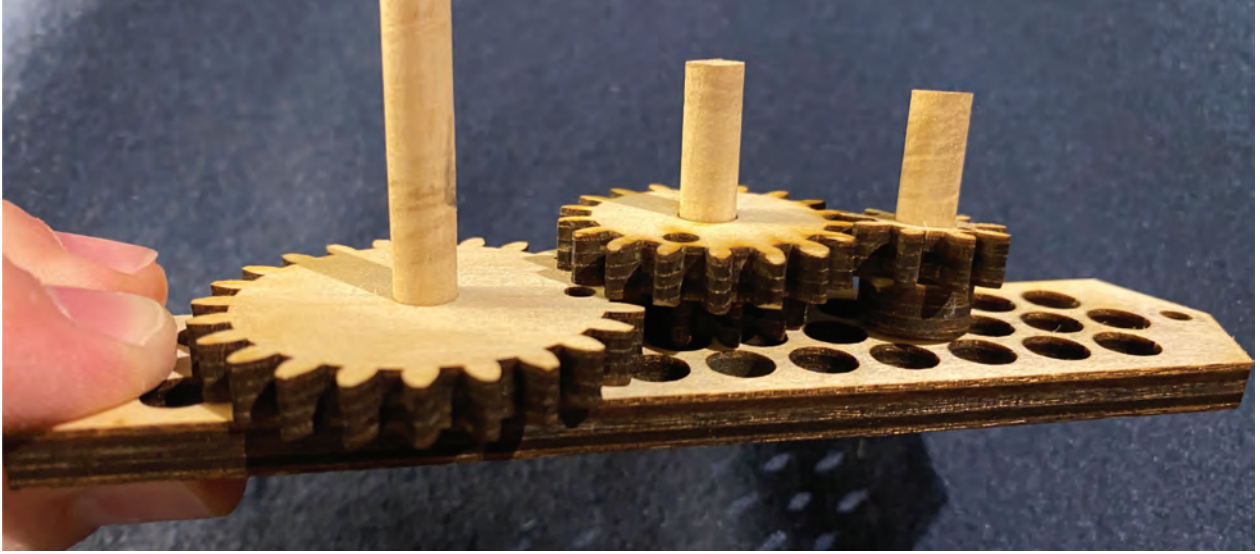
Part 4: Adding More Gears

Add the second-largest gear on top of the smaller gear. Push it down so they are resting on top of each other.
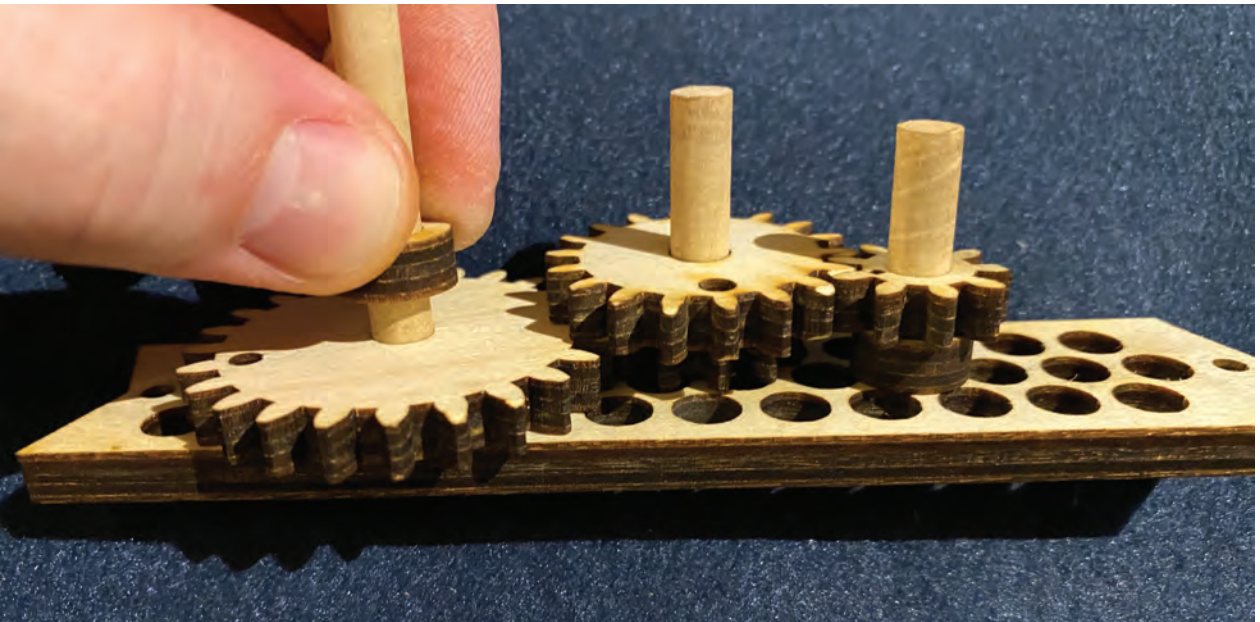

Grab another short peg and add the smallest gear and a spacer ring. Push them together so they are resting on top of each other.
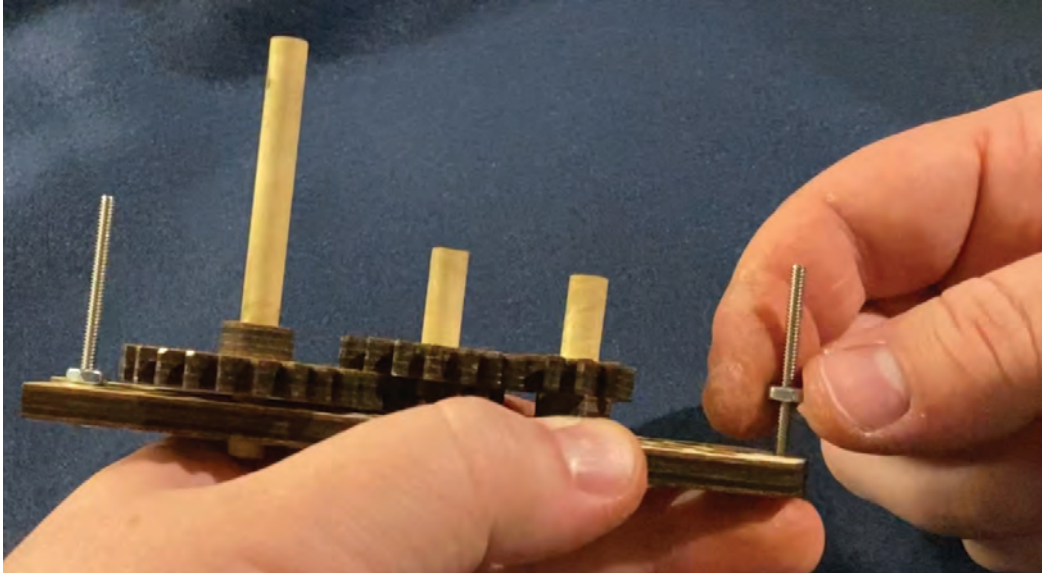
Part 4: Adding More Gears

Add this gear and spacer so that it fits in next to the other top gear. We should have all four gears on now!
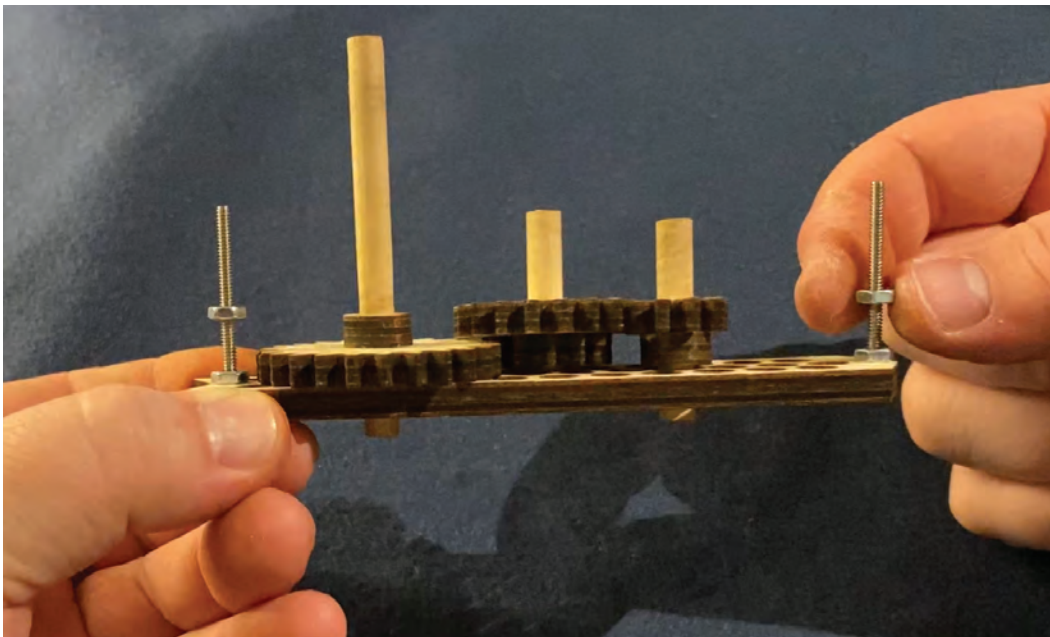

Add the second spacer on top of the biggest gear. Now each peg should have two layers that all line up on top.

Part 5: Securing the Gears in the Frame

Put a screw through each of the small end holes on the frame so that they point in the same direction as the pegs. Add a nut on each screw and tighten it all the way down with your fingers.
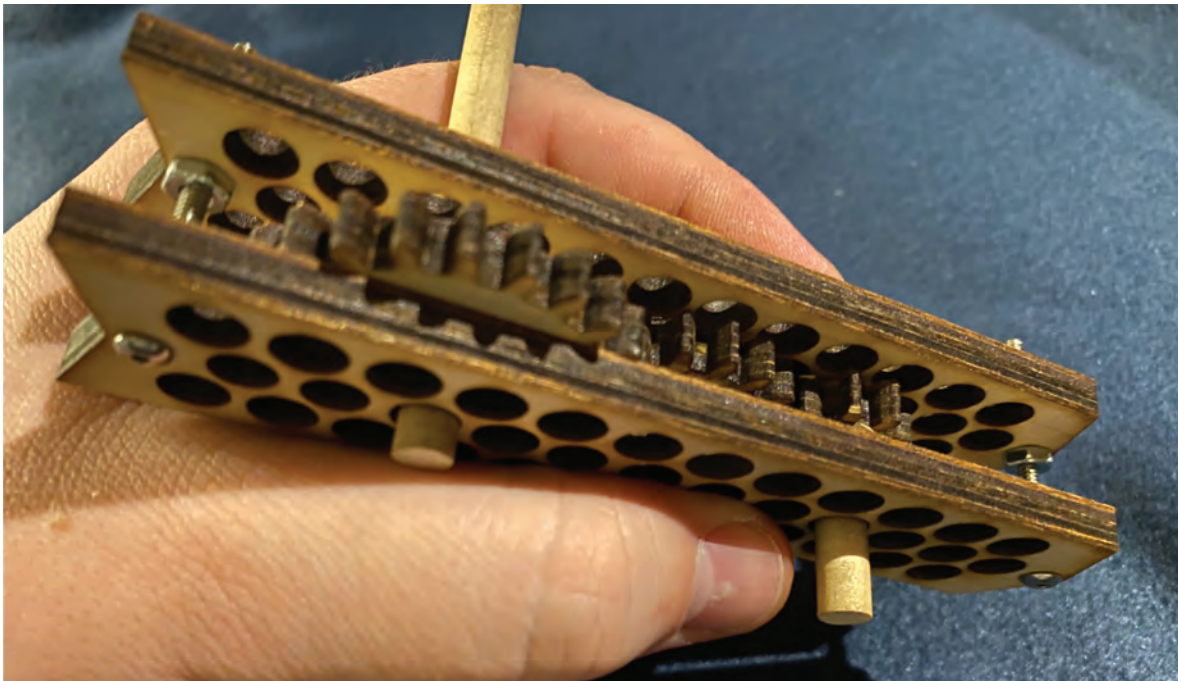

Add a second nut onto each screw. Twist them down until they are just a little bit higher than the top of the gears.

Part 5: Securing the Gears in the Frame
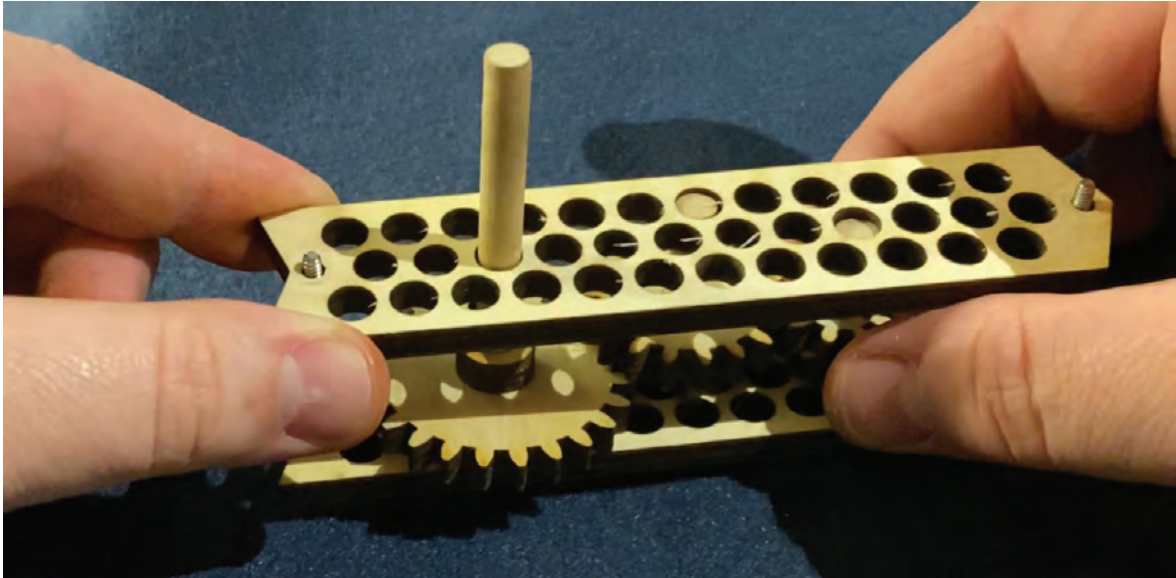
Grab the second piece of the frame and lower it down on top of the gears. It should rest on top of the nuts you just added to the screws. Make sure all your holes line up right!

Push on the shorter peg on the end so that it sticks out a little more on the end. If it's too hard to push, you can take off the top piece and slide things around a bit.

Part 5: Securing the Gears in the Frame
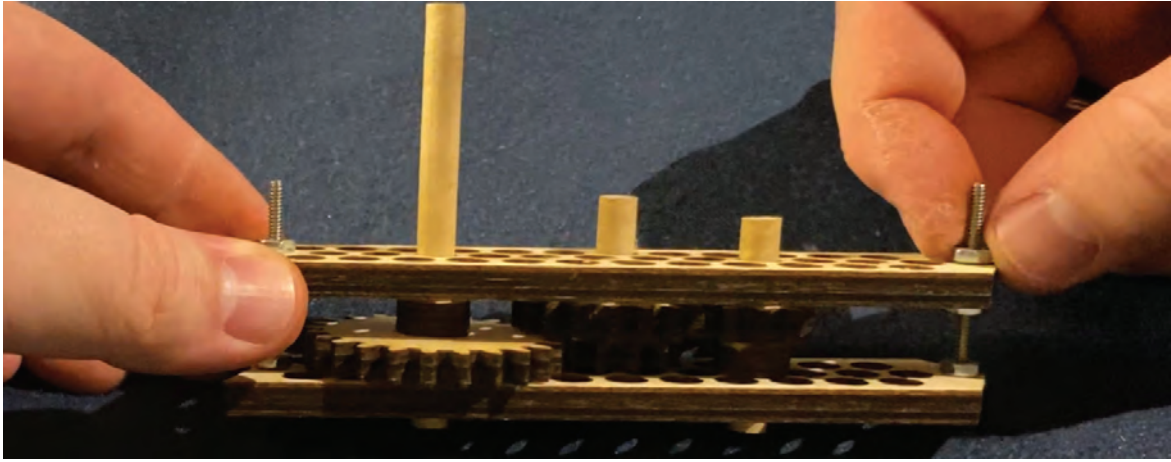
Add the last two nuts onto the ends of the screws and tighten them all the way down with your fingers.
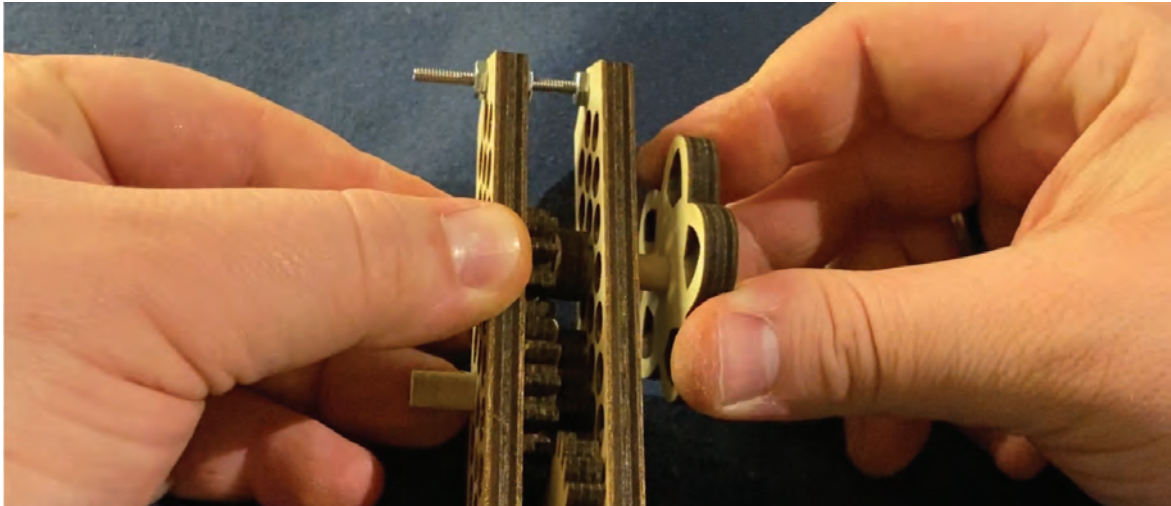
Now, add the star spinner onto the end of the peg you just pushed out.

Let's test it out! Twist the long peg and watch the star spin!

Part 6: Finding the Gear Ratio

Now that we have all the gears working together, let's try to figure out what's going on. We want to look at each place two gears are meshing—where their teeth are meeting up.

We have two pairs: 1) yellow and red, and 2) blue and green. How many teeth does each gear have?

number of teeth

number of teeth

number of teeth

number of teeth
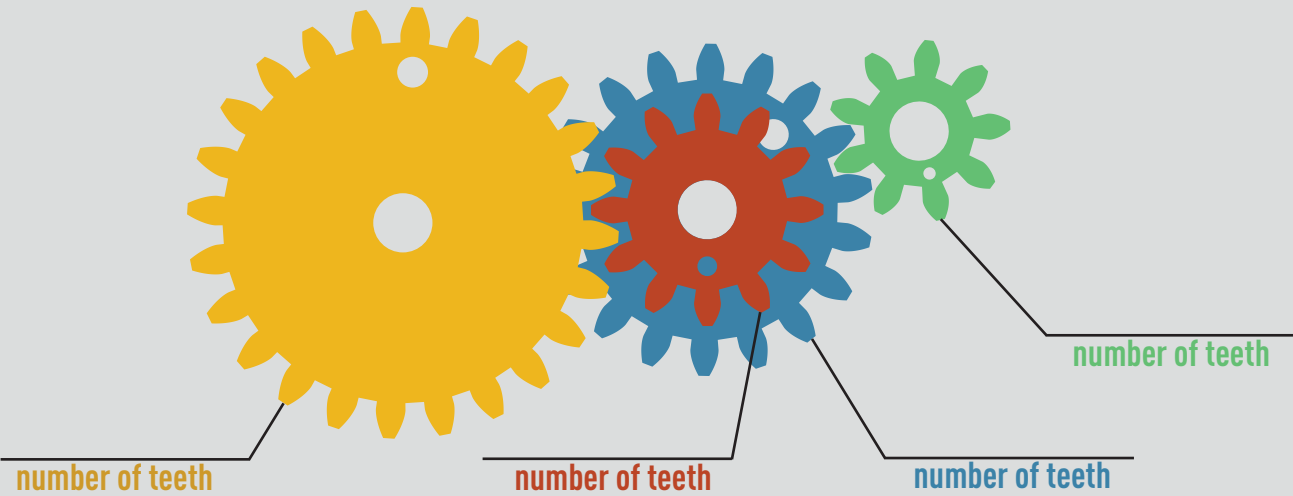
Now we divide the input gear number (the gear we are spinning) by the output gear number (the gear that it pushes). In this case, we're spinning the big yellow gear, and it pushes the red gear.

$$\frac{\boxed{}}{\boxed{}} = \underline{}$$

$$\frac{\boxed{}}{\boxed{}} = \underline{}$$

And now we multiply these two results together. When we spin the yellow gear one time, the green gear spins around that many times. We call this number the *gear ratio*. Awesome job!
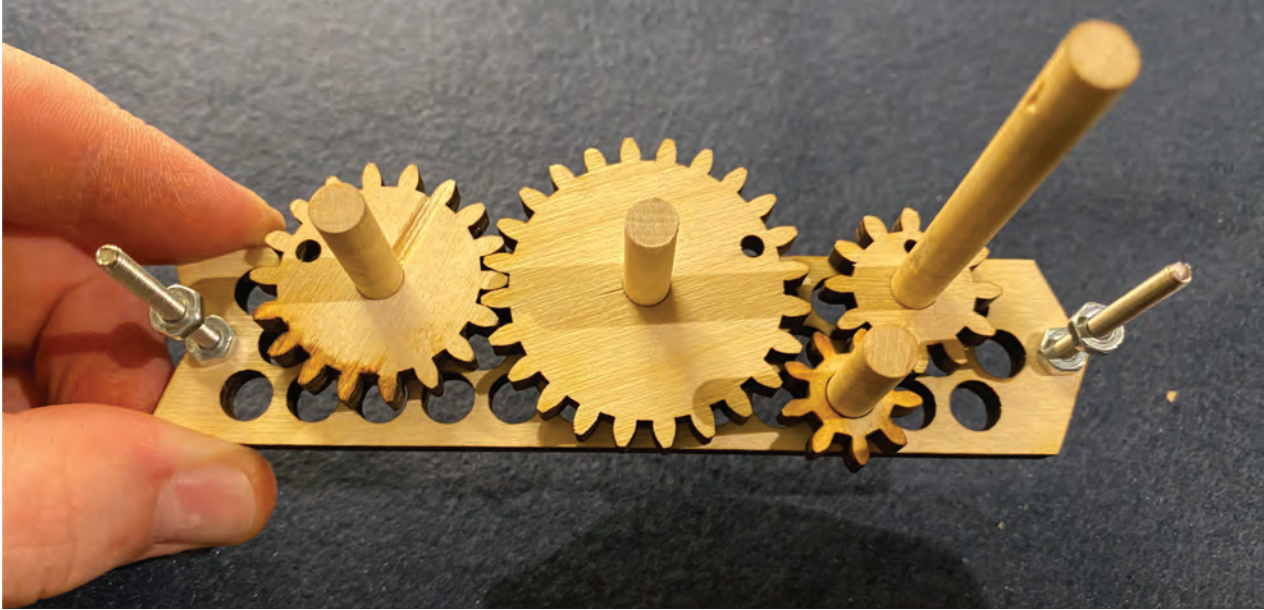
12 $\boxed{} \times \boxed{} = \underline{}$

Part 7: Experimenting

Let's see what other positions we can put our gears in. Feel free to play around and make your own combinations of gears.

You can build up your own stacks of gears, or you can try putting them all in line with each other. See if you can figure out what the different gear ratios are.

What combinations go fast? What combinations go slow?

Part 8: Reflection and Discussion Questions

What other gear combinations did you come up with? Sketch a picture of your favorite here:

Can you think of a use for a gearbox that makes things go faster?

Can you think of a use for a gearbox that makes things go slower?

Why do you think we need nuts on both sides of the top frame piece? What would happen if we took the bottom ones out?