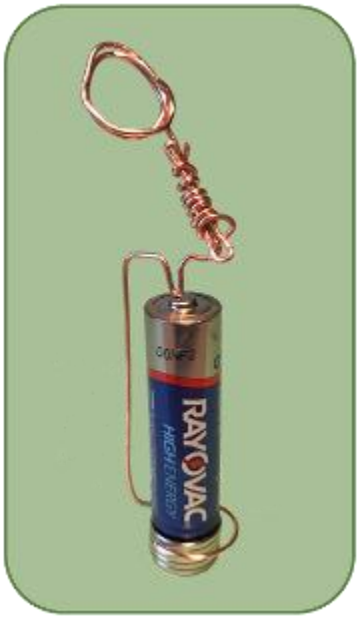
Homopolar Motor



These instructions will take you through the step by step process required to build your very own spinning copper contraption (aka homopolar motor). We had a lot of fun, and some failures, during our homopolar motor investigation, but if you follow these instructions you should have your homopolar motor working in no time.

Note: The homopolar motor is a fascinating project to try with your kids, but it's also a project that can be a little frustrating for them. Double check our troubleshooting tips if your kid's homopolar motor doesn't want to continuously rotate.

Step 1 - Supplies:

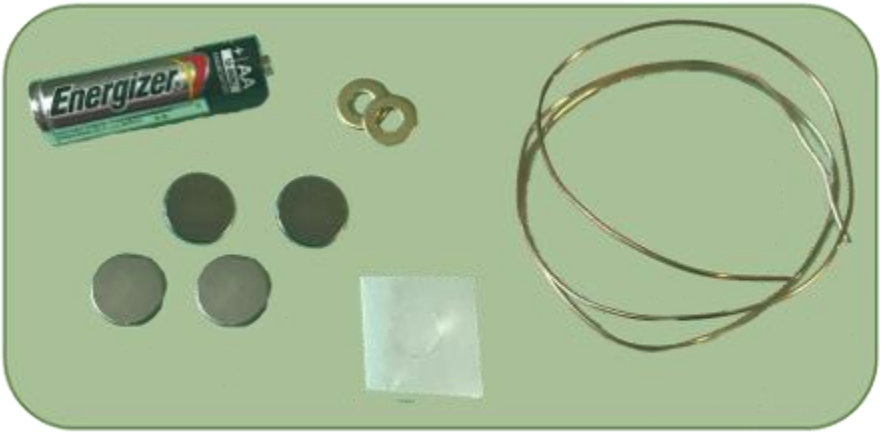


Image 1.1

1.1 We made our homopolar motor using a AA **battery** with **15mm neodymium magnets**. If you have trouble finding 15mm neodymium magnets, use a **AAA battery** with **12mm neodymium magnets** instead. During our investigation, we found that the AA battery was just enough bigger in size to make the construction of our homopolar motor less stressful.

1.2 Designing our copper contraptions was quite a bit of fun but we couldn't seem to get any of them to stay on the battery's positive terminal. We were able to solve this dilemma by using an **Instant Tacky Sticky Dot** to attach two **brass washers** over the terminal. This created a band around the terminal that acted as a guide for our contraptions.

Note: You need to make sure the washers just fit over the battery's positive terminal. If the washer's center hole is too wide, then the copper contraption could get jammed between the washer and the terminal.

1.3 The amount of **bare copper wire** needed to build your spinning contraption will vary, depending on your kid's design. We used about 18 inches for our magnifying glass contraption.

Step 2 - Testing:

2.1 If you haven't already done so, be sure to test your battery. The homopolar motor often requires some tweaking, in the end, to get the copper contraption working so it's best to know from the start that the battery isn't the problem.

Note: The homopolar motor will drain your batteries rather quickly. If you don't already own a multimeter, now is the perfect time to add one to your home/classroom makerspace.

Step 3 - Build:

If you recall from our **How the Homopolar Motor Works** tutorial, the positive terminal of your battery needs to be connected to your neodymium magnet(s) with bare copper wire. We chose a compact design for our copper contraption for its stability. This design will also allow your kids to get inventive and add a personal touch to the top of their contraption (**Image 3.3**).

Image 3.1

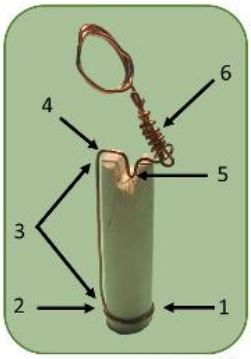


Image 3.2


Image 3.3

Image 3.4

3.1 During our investigation we found it easier to build the copper contraption (**Image 3.3**) after we assembled the rest of the parts. This allowed us to double check our measurements as needed.

3.2 Place the negative end of the AA battery on top of your magnets (**Image 3.1, step 1**).

Note: You shouldn't need as many magnets as you see in **Image 3.1**. We had a lot of success with just three magnets stacked together. Fewer than three magnets didn't give us enough wiggle room if we had to adjust the arm and/or ring of our contraption to obtain the best contact with the magnets.

3.3 Use a small piece of adhesive to attach your brass washers around the battery's positive terminal (**Image 3.1, step 2**).

Note: As mentioned earlier, the brass washers aren't mandatory, but we found our copper contraption tended to slip off the positive terminal without them.

3.4 It's now time for your kids to get their creative juices flowing. Feel free to follow the rest of these instructions step by step or use this information as a guideline if your kids already have their own ideas.

Note: We did some brainstorming during our investigation to see if we could make this next section easier for teachers who want to attempt this project with a larger group of kids. The wooden dowel template in **Image 3.2** is just one way of helping your students build their contraption with precise measurements.

3.5 Wrap one end of your copper wire around a wooden dowel until its wrapped almost all the way around (**Image 3.2, step 1**).

Note: For our 15mm neodymium magnets, a 5/8" wooden dowel was a perfect size. You can also have your kids wrap the copper wire around the magnets themselves, but we found it hard to get a nice fit this way.

3.6 Use pliers to make a 90-degree bend upward in the wire just before the wire wraps completely around the dowel in the previous step (**Image 3.2, step 2**).

3.7 Calculate how tall the arm of your contraption needs to be (**Image 3.2, step 3**). This measurement should include the distance from where the wire wraps around the magnets up to the bottom of your battery, the height of the battery (including the terminal), plus an additional quarter inch for the section that hovers over the battery terminal (**Image 3.2, step 3**).

3.8 Make another 90-degree bend in the copper wire, bending inward this time (**Image 3.2, step 4**).

3.9 This next section can be difficult to measure which is why we liked creating the wooden dowel template.

After creating the 90-degree bend inward in the previous step, you need to create the section that hovers over the battery's positive terminal. This section needs a 1/4" V bent into the wire so that the V will touch the battery's positive terminal (**Image 3.2, step 5**) leaving an equal length of wire on each side.

3.10. Make one last bend up and inward so that whatever design your kids decide to create will balance above the battery (**Image 3.2, step 6**).

3.11 Your kids can now bend the rest of the copper wire into any design they'd like and remove any extra length.

Note: You may need to help your kids make sure that this top section is centered over the battery.

Step 4 – Troubleshooting Tips:

Helping your kids build their homopolar motor shouldn't take long. Helping them adjust the motor so it will continuously rotate might. Hopefully, these tips will help your kids get their homopolar motor spinning in no time.

If you haven't already done so, make sure your kids are using a working battery.

Make sure your kid's copper contraption is making enough contact with their magnet(s). Both sides of the copper ring that circles the magnet(s) should have some contact with the magnet(s).

If after making sure the above two issues aren't a problem, help your kids adjust the arm of their copper contraption. The arm is the section of wire that runs up the side of the battery and this adjustment was the one that helped us the most. Just a slight bend halfway up the arm seemed to help with the weight distribution so the ring at the bottom stayed connected to the magnets.