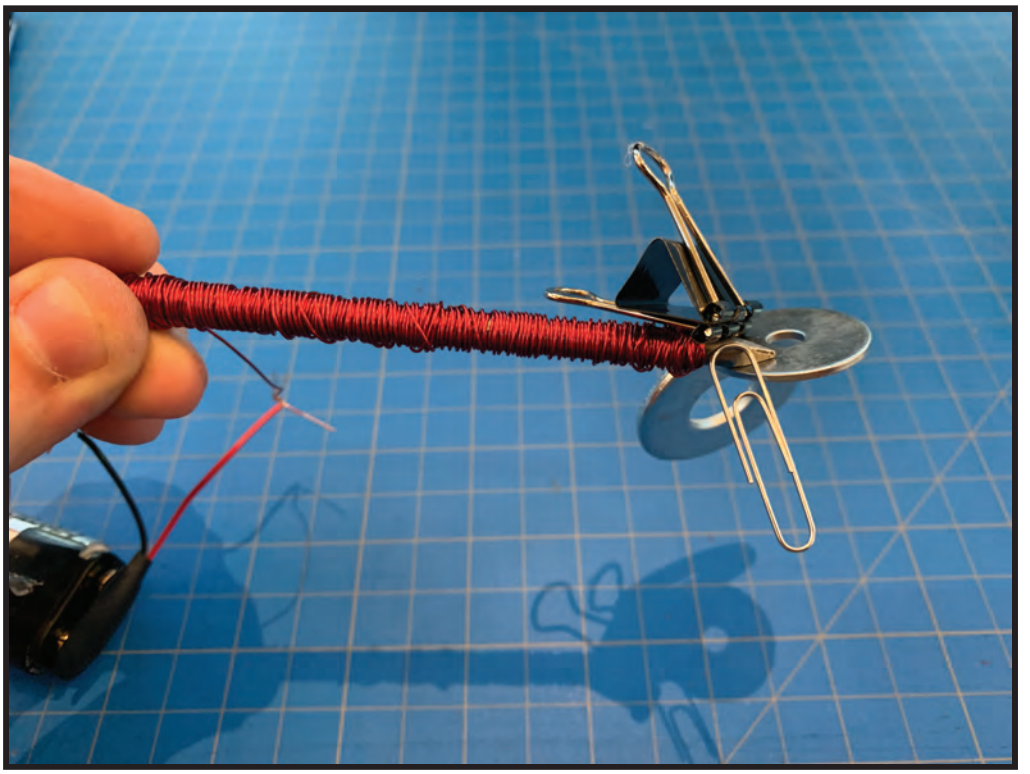
SHIFTING RHYTHMS

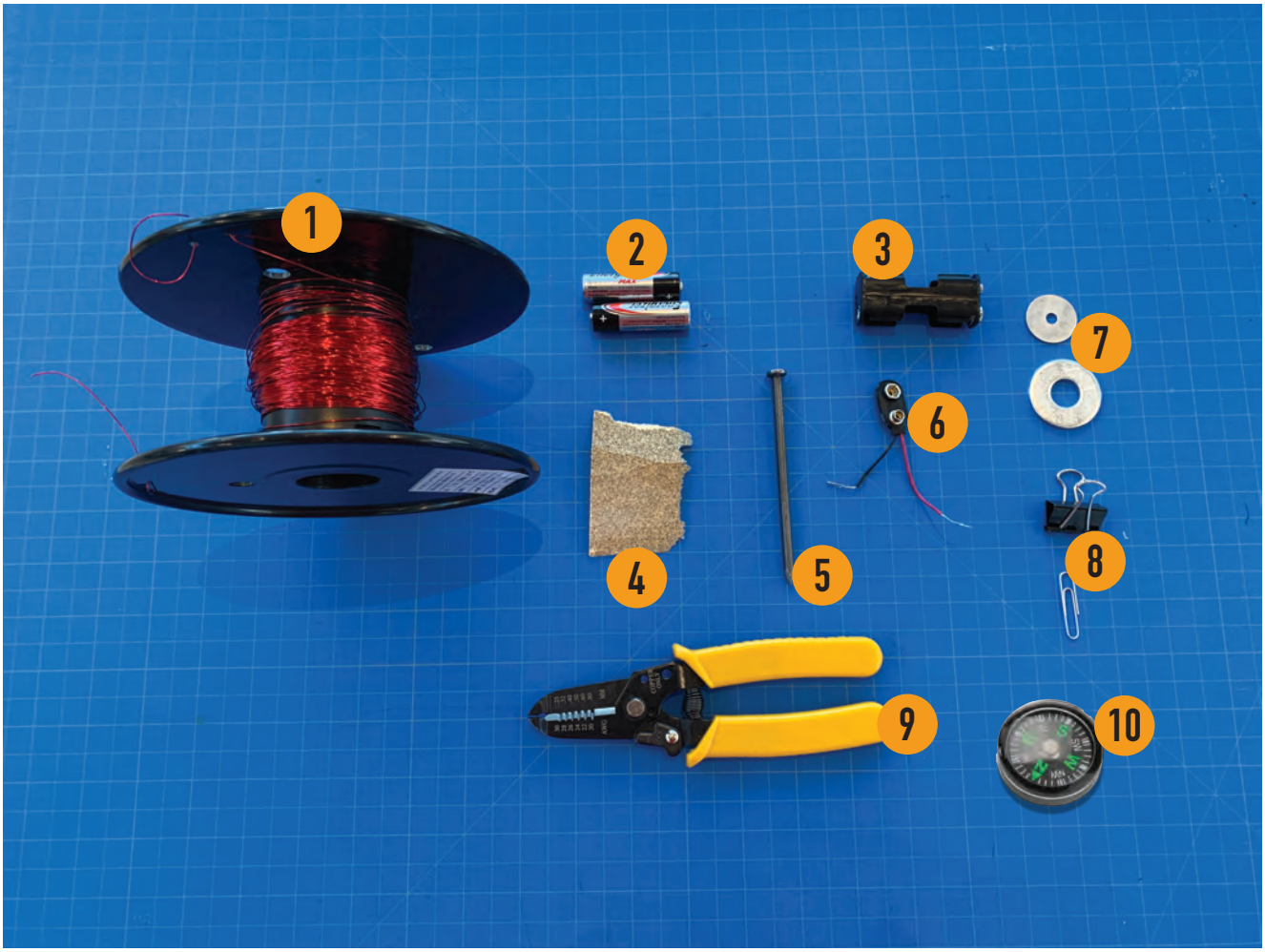
ELECTROMAGNETS

Time Estimate: 1 hour



Tags: Electrical

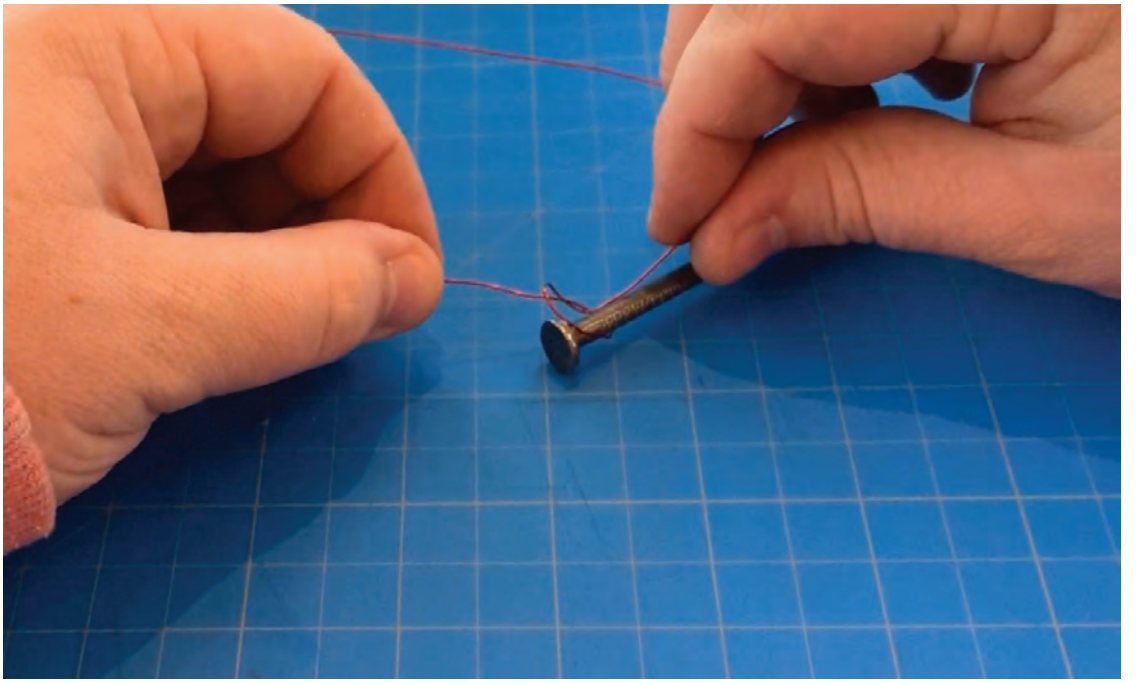
Part 1: Materials and Tools



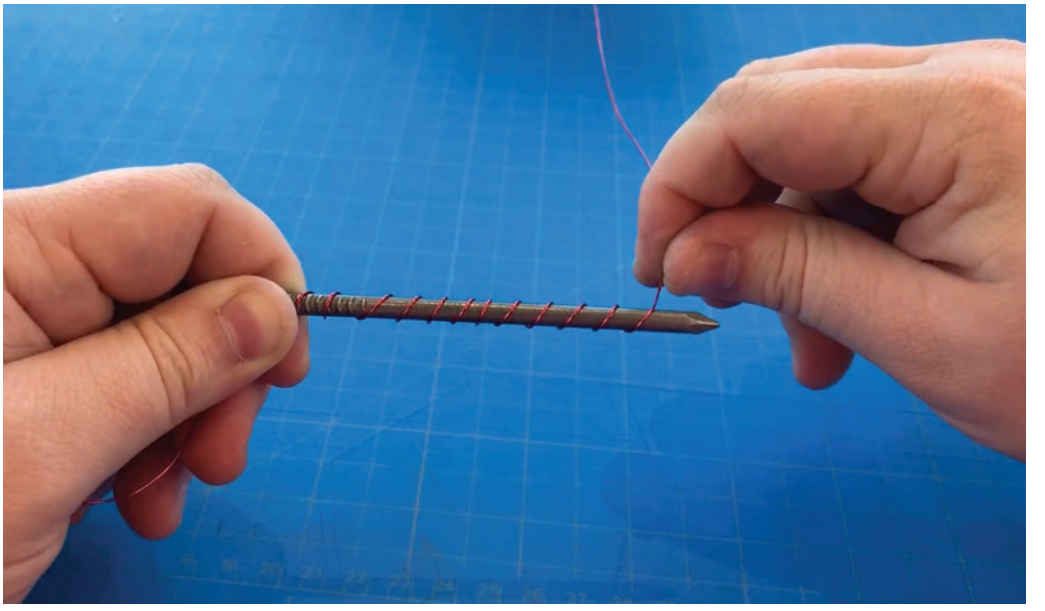
To build your electromagnet, you'll need:

1. Coated Copper Wire
2. AA Batteries (x2)
3. AA Battery Holder
4. Sandpaper
5. Iron Nail
6. Battery Pack Connector
7. Washers
8. Lightweight Metal Things
9. Wire Strippers
10. Compass

Part 2: Wrapping the Wire

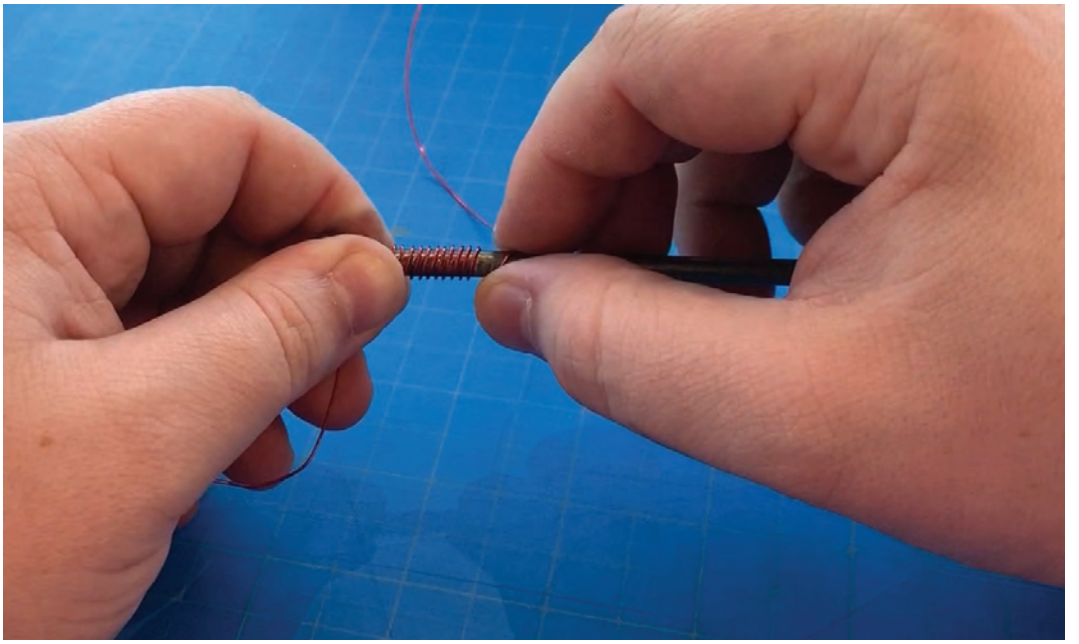


Wrap some wire around the top of your nail and tie a knot to secure it. Make sure you leave a couple extra inches of extra wire on one end—we'll need it later!

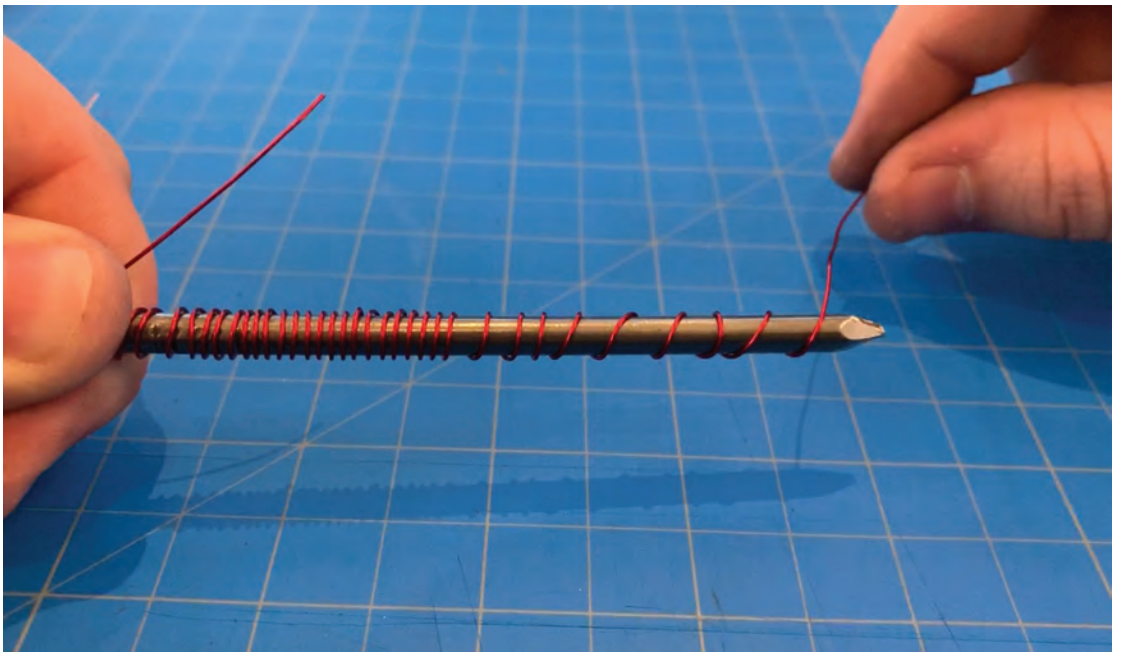


Hold the tied end in place and start wrapping the other end around the nail. These wraps are called coils.

Part 2: Wrapping the Wire

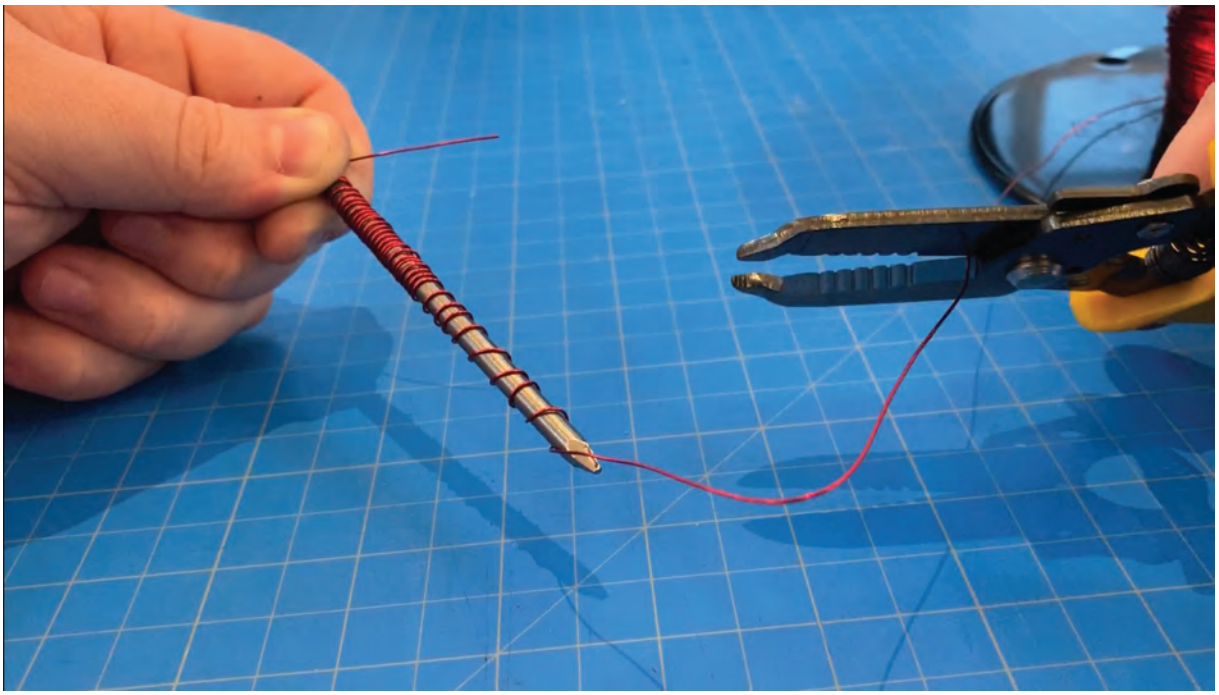


Push the coils down toward the end of the nail so you have room for more coils.

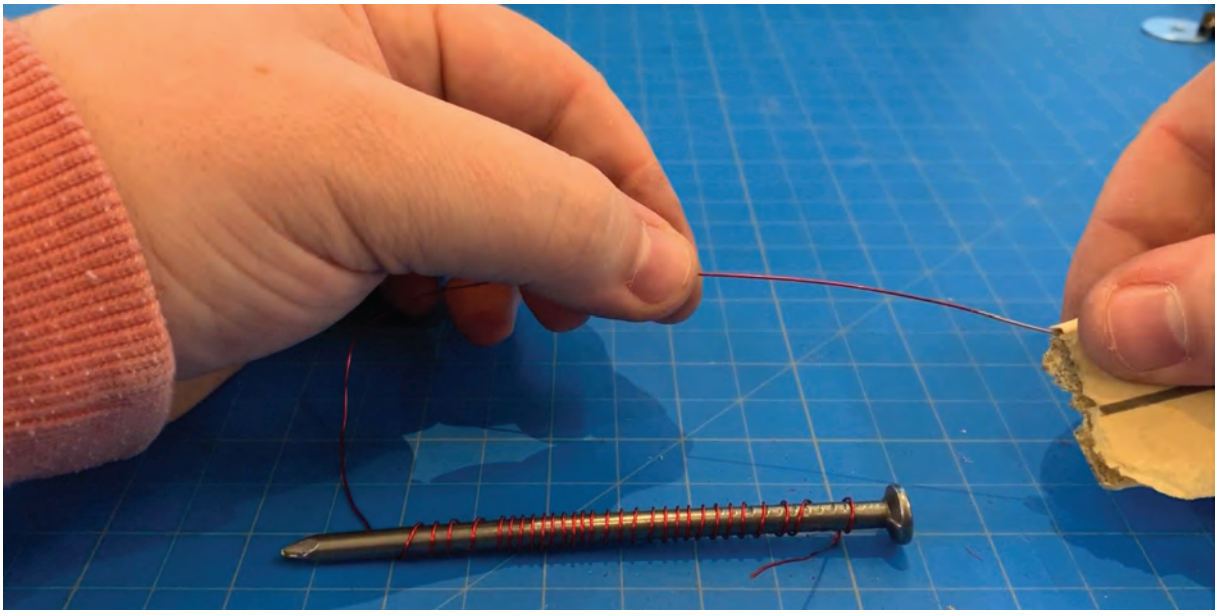


Keep wrapping until you reach the top of the nail again.

Part 2: Wrapping the Wire

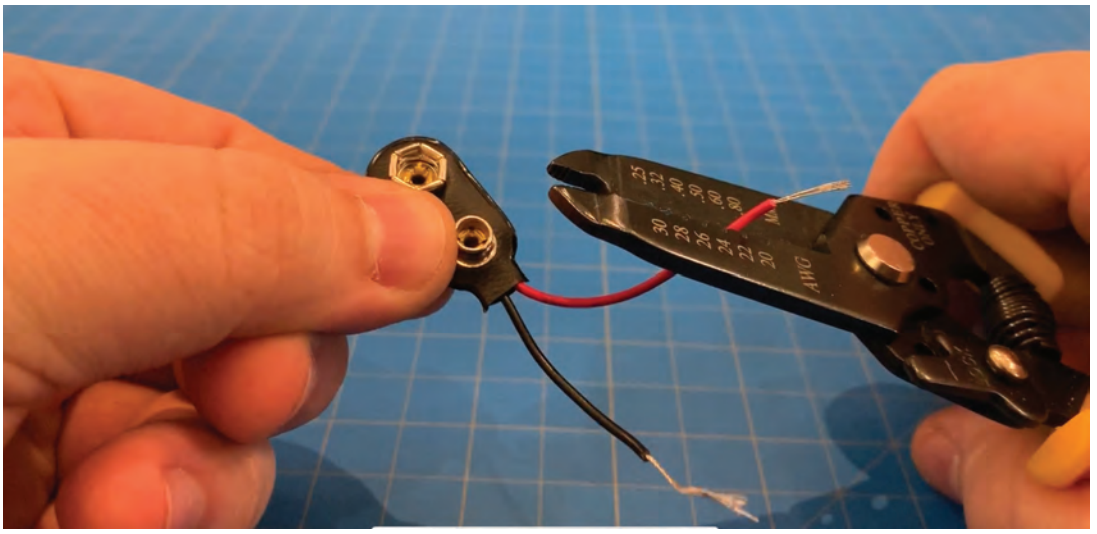


Use the cutting part of the wire strippers to cut off the wire from the spool. Leave a few inches again!

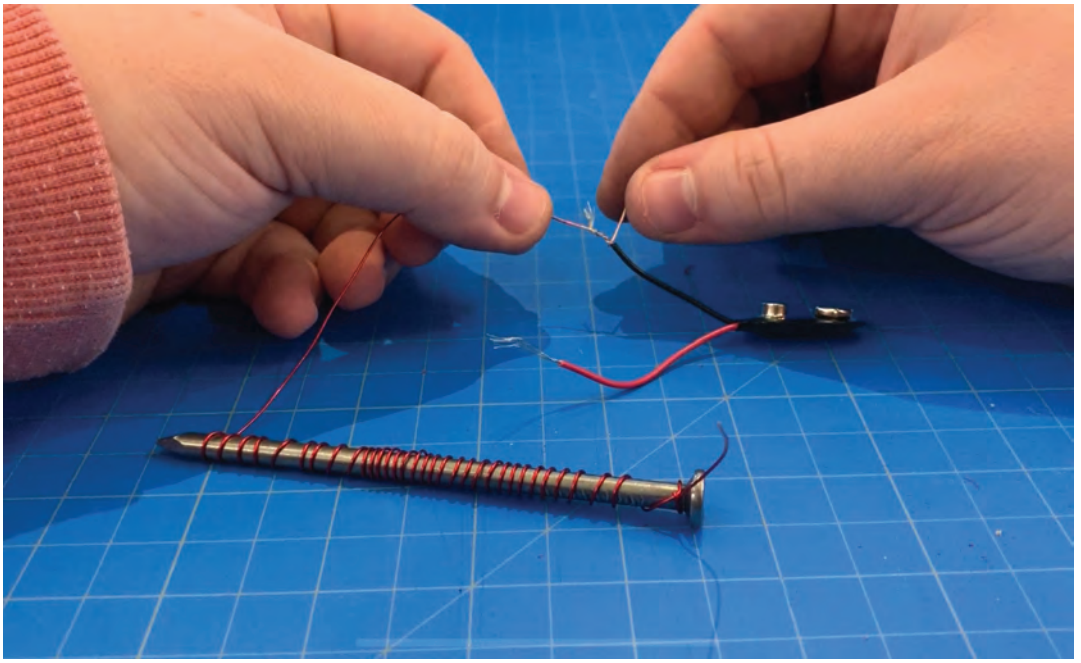


Tear off a small piece of sandpaper and fold it around the end of the wire. Slide the wire through the sandpaper as you squeeze to take off the red coating on the wire. Keep going until you see the silver show through. Do this for both ends of the wire.

Part 3: Adding the Electronics

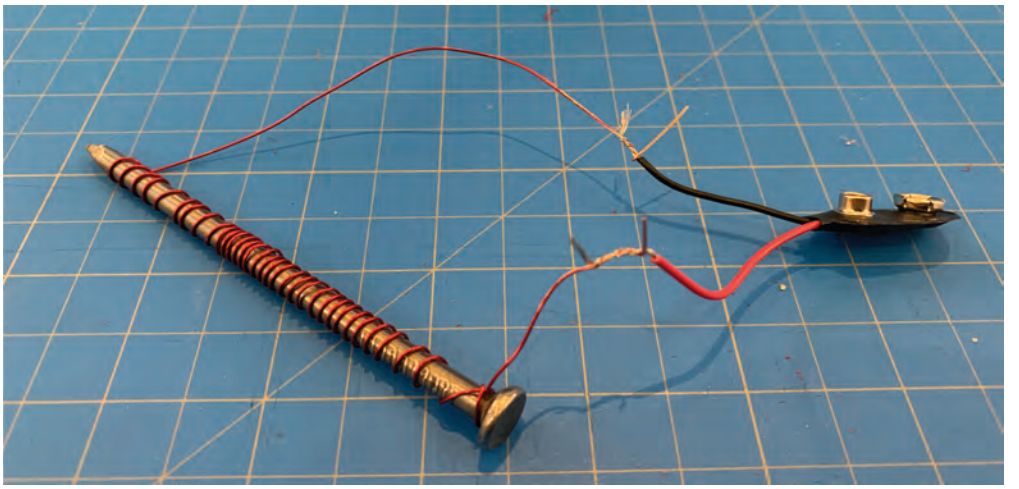


Use the lower two holes on the wire strippers to remove the coating around the battery connector wires. Remove enough so that the exposed wire is about the width of your thumb.

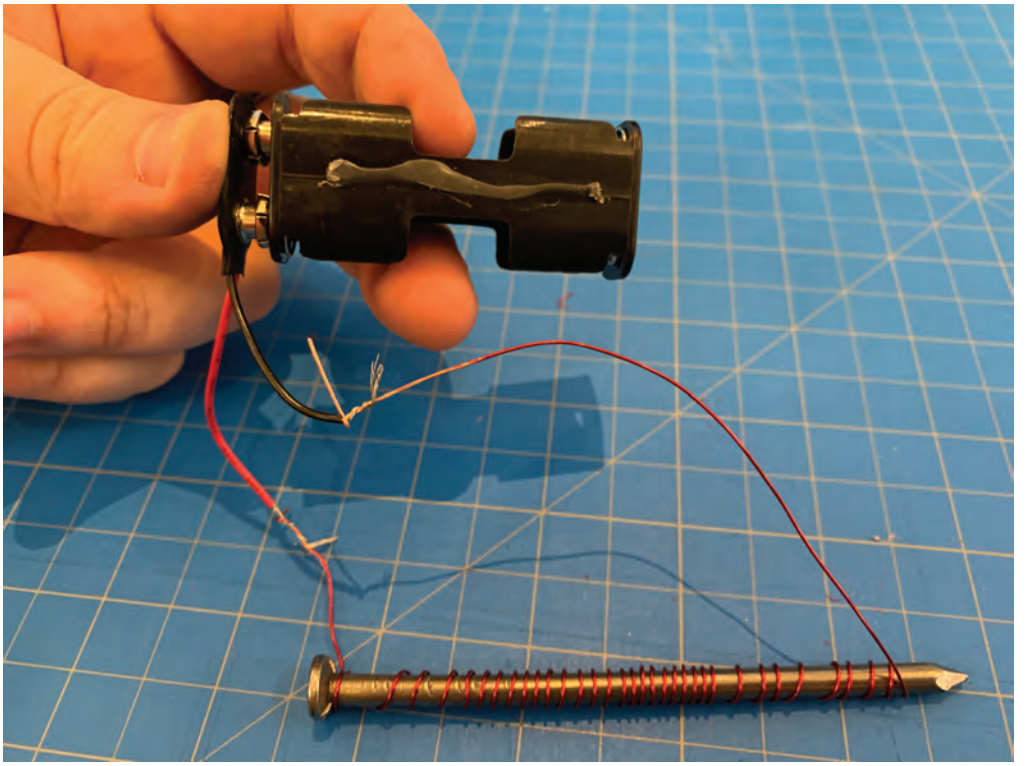


Twist one end of the coiled wire together with one end of the battery connector wire. Twist several times to make sure they're secure!

Part 3: Adding the Battery & Testing

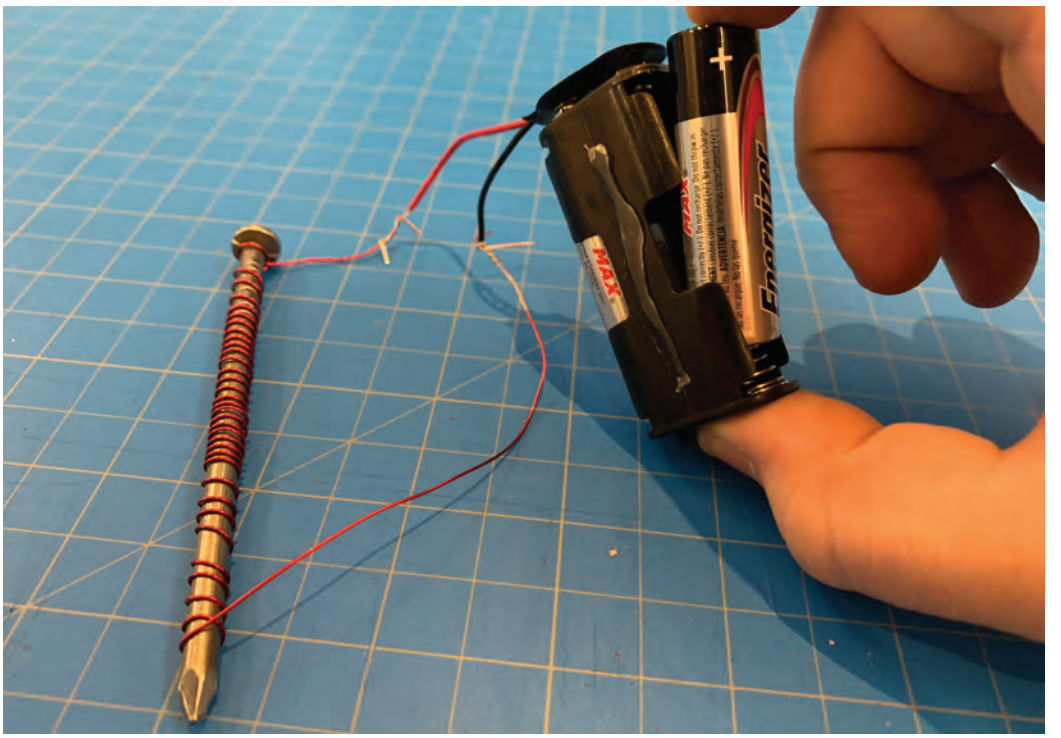


Twist the other wire ends together so that the whole thing makes a big loop. Do you remember what a loop of electricity is called? Where have we done this before?

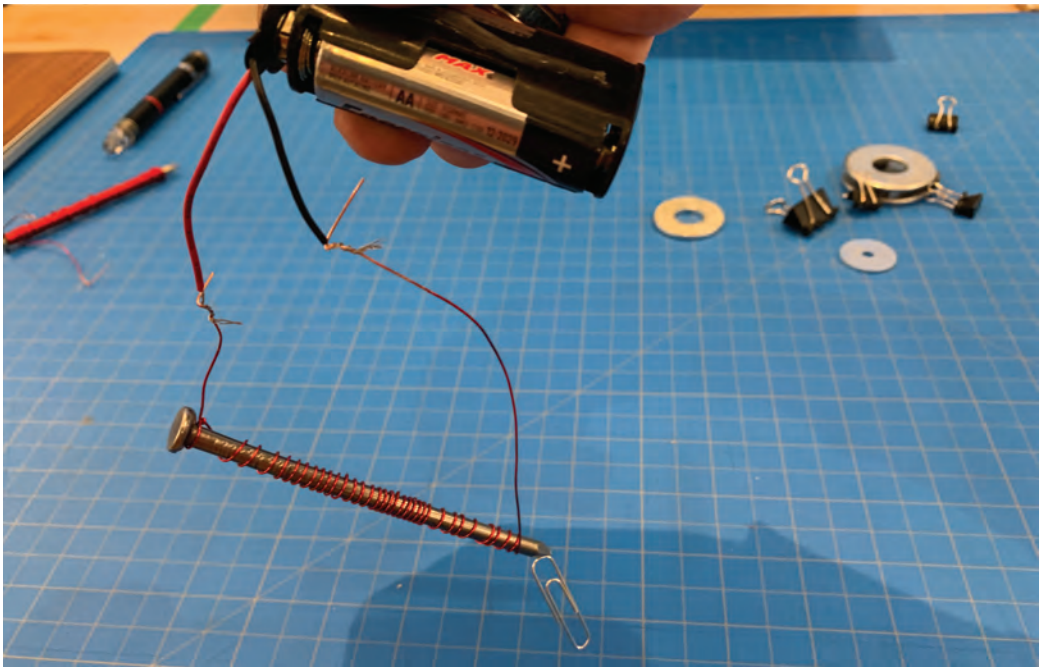


Snap the battery case onto the battery connector.

Part 3: Adding the Battery & Testing

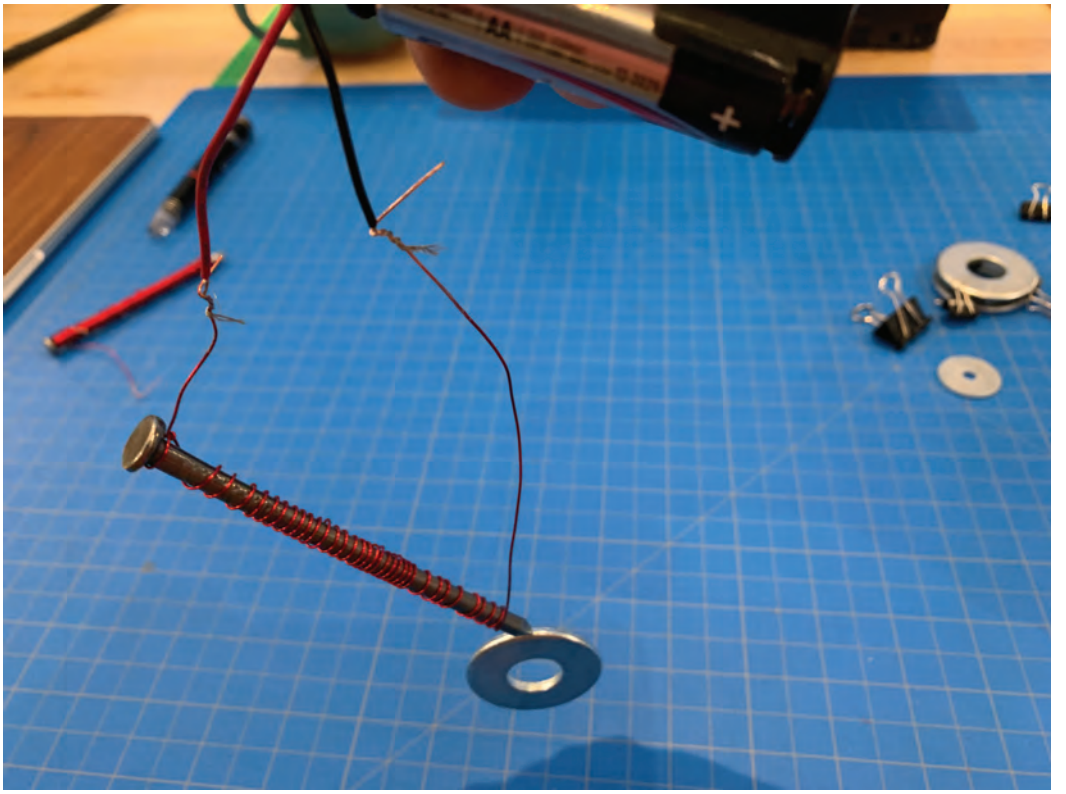


Put the batteries into the battery pack. The flat end of the battery goes up against the spring.



Believe it or not, you now have a working magnet! Try picking up something small like a paper clip.

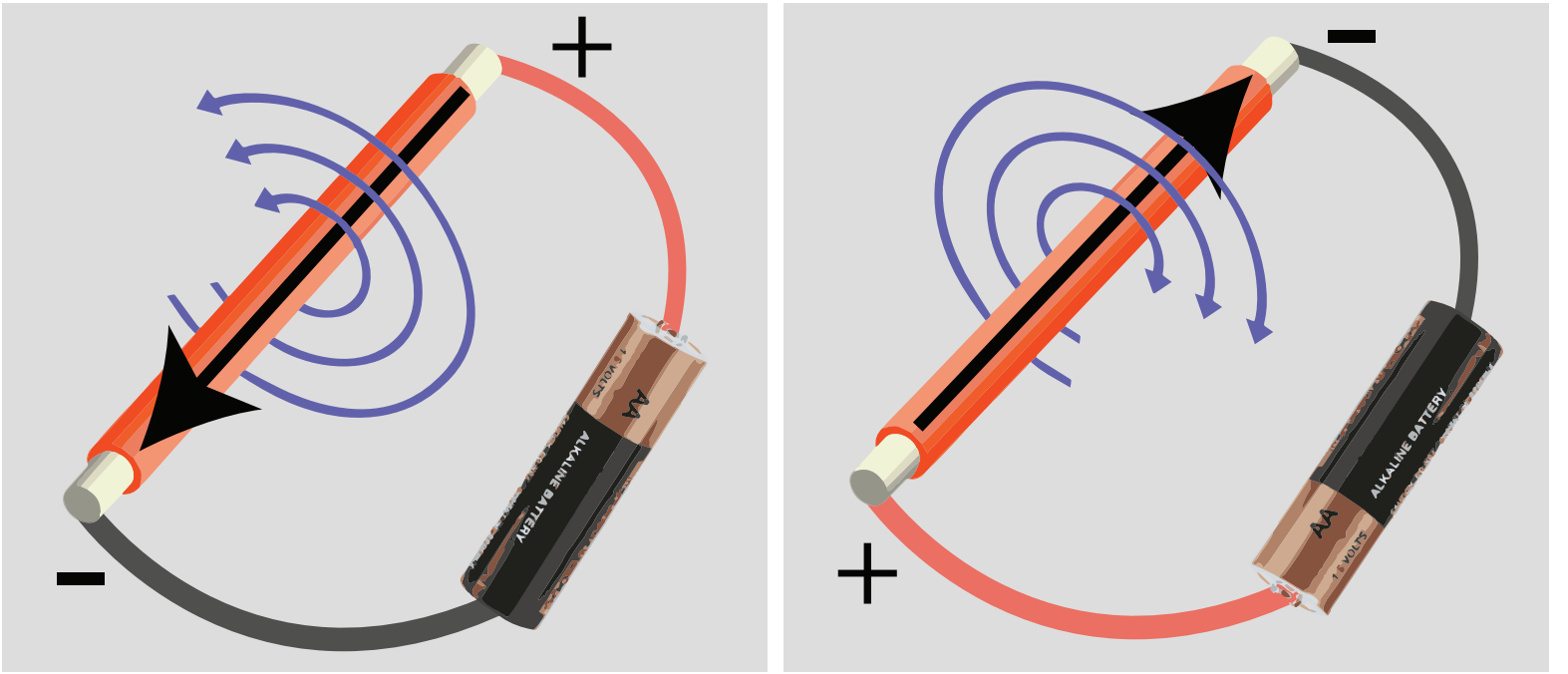
Part 3: Adding the Battery & Testing



Try something heaver like a washer. Can you pick up more than one thing at a time? What is the heaviest thing you can pick up?

Part 4: How Does This Work?

How did we just make a magnet with only a nail, some batteries, and some wire? Let's learn a little more about how this works.

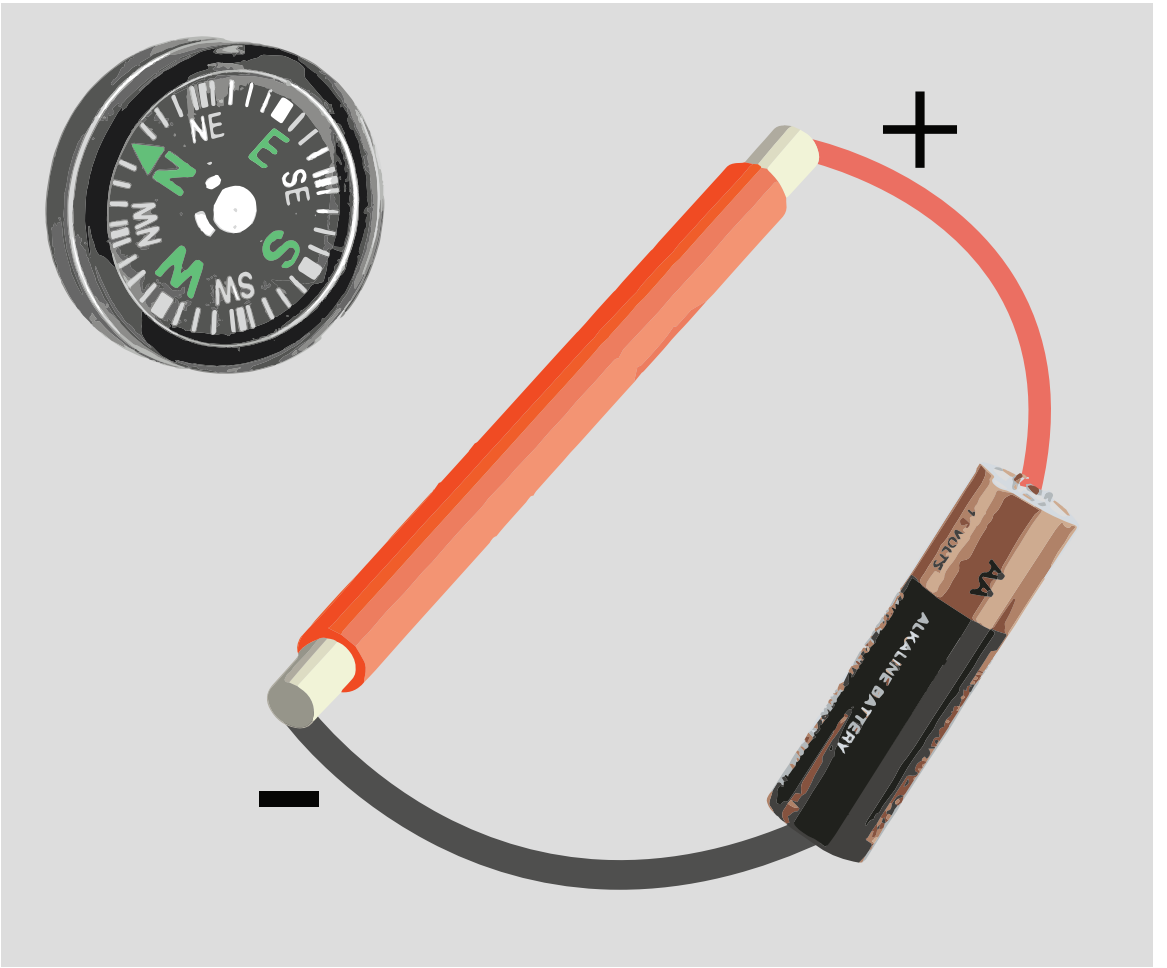


When we run electricity through a wire, like when we attach it to a battery, the electricity makes something called an "electromagnetic field." That's what those blue lines are in the pictures above.

Electricity flows from the positive (+) end of the battery to negative (-) end. The positive end is the one with the little bump on it, and the negative end is the flat side. The black arrow shows what direction the electricity is flowing.

When we attach our battery to the wires going the other way, the direction of the electromagnetic field also changes. Notice how the blue lines change direction when the battery gets flipped around.

Part 4: How Does This Work?



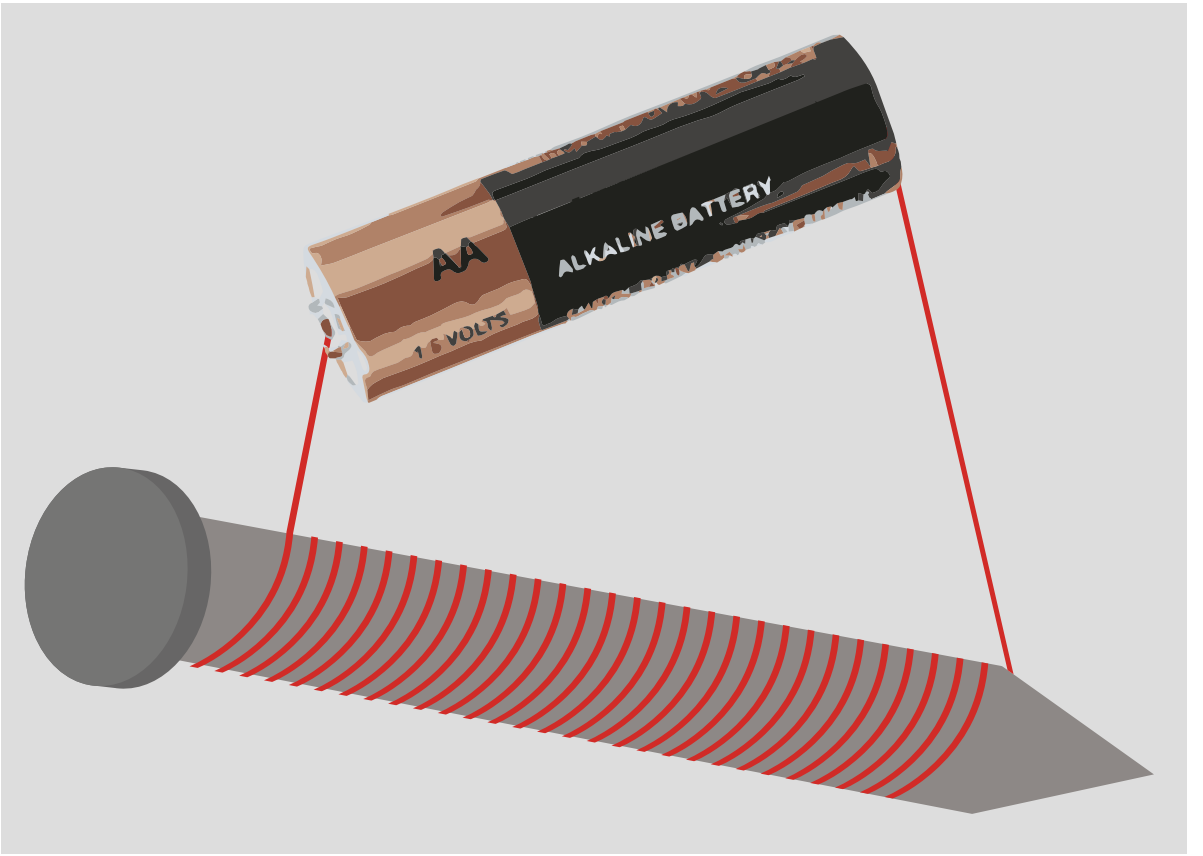
Cut off a new piece of wire several inches long and sand down the ends.

Connect the battery pack wires to the ends of this straight wire. The red wire is the positive and the black wire is the negative.

Does the compass spin around?

If you change the battery's direction, what what happens to the direction of the compass?

Part 4: How Does This Work?



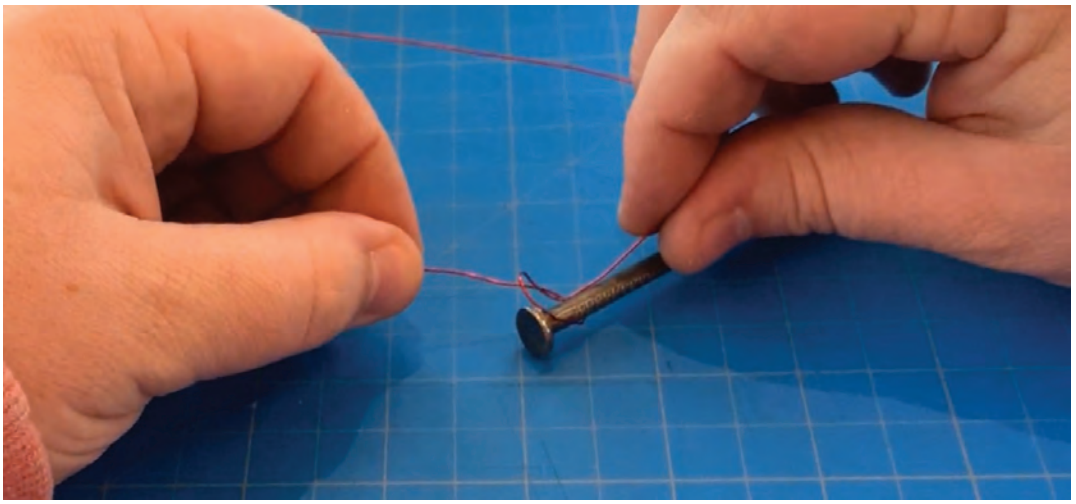
When we have just one piece of straight wire, the electromagnetic field is very weak. It gets stronger when there is more wire for the electricity to travel through.

When we coil up our wire around the nail, this gives the electricity more wire to travel through, so the field becomes stronger.

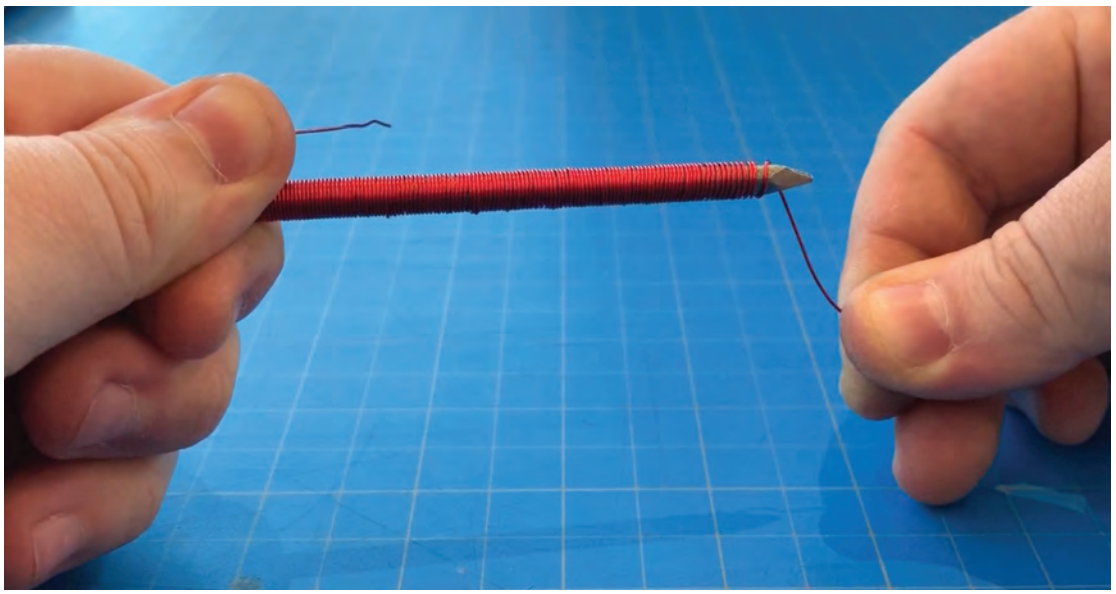
The nail is made of a magnetic material called iron. When we put a piece of iron in an electromagnetic field, the iron also becomes part of the field and helps make the field even stronger.

Part 5: Adding More Coils

This means that if we add more loops of wire around the nail, our magnet will become stronger!

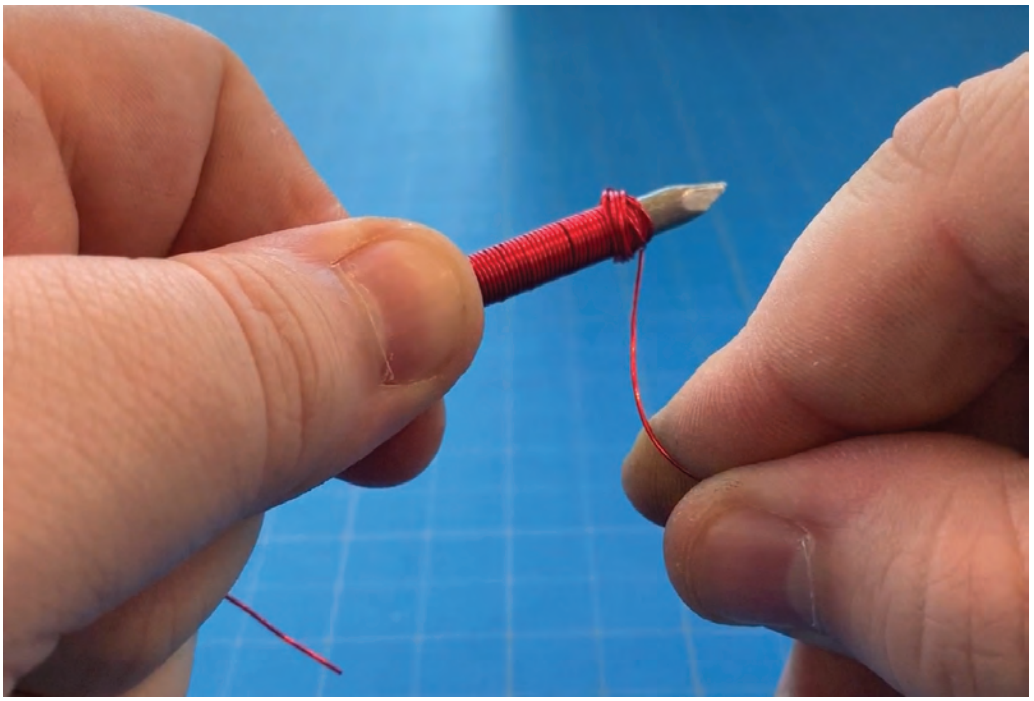


Take the wire off of your old nail and start again by tying a new piece of wire around the end of your nail.

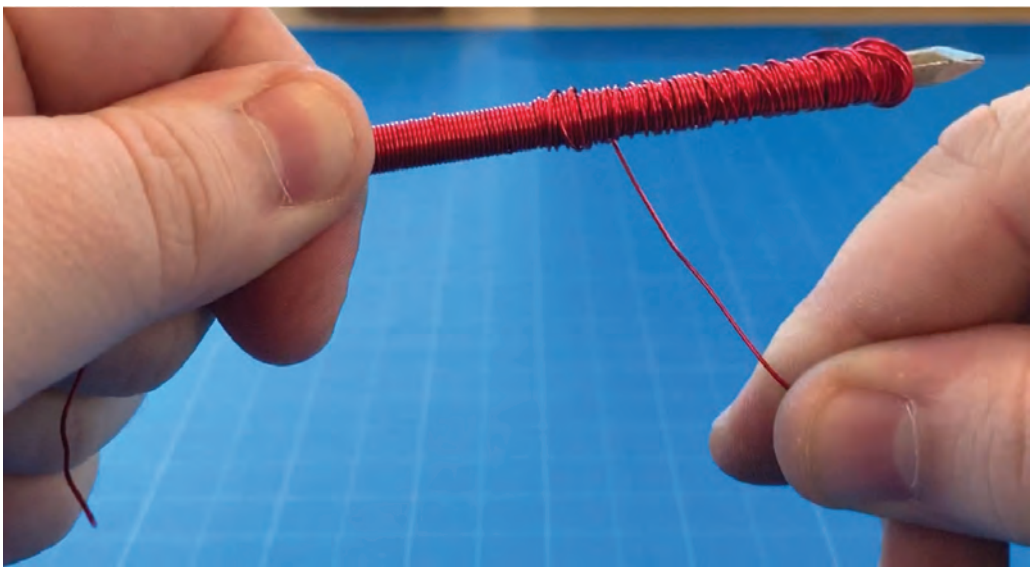


Just like before, wrap around the nail and squish the coils down to one end. Keep doing this until the nail is completely covered in coils like in this picture.

Part 5: Adding More Coils

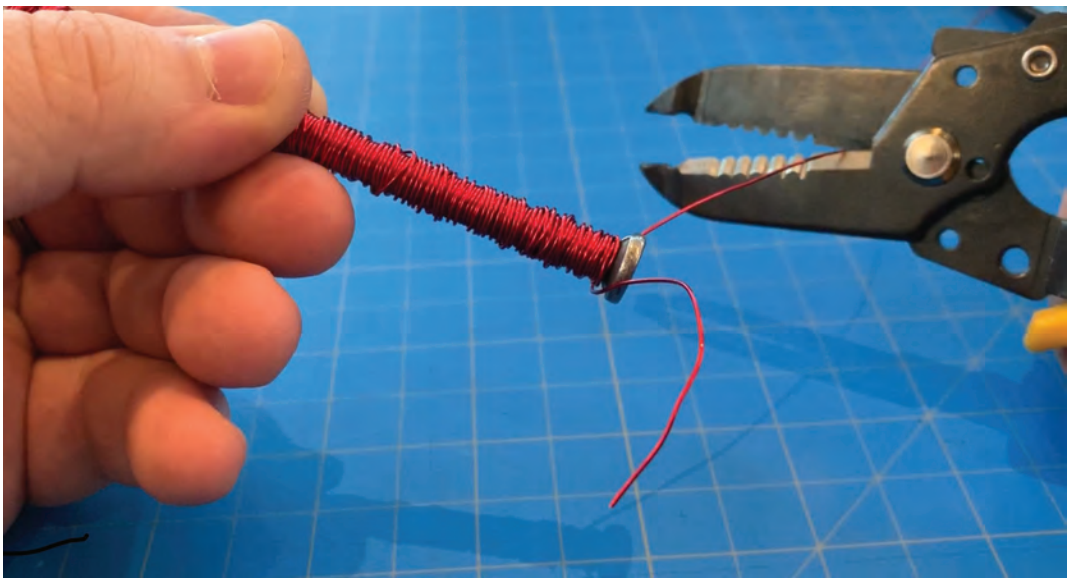


When you get to the pointy end, wrap it around a few extra times to secure it.

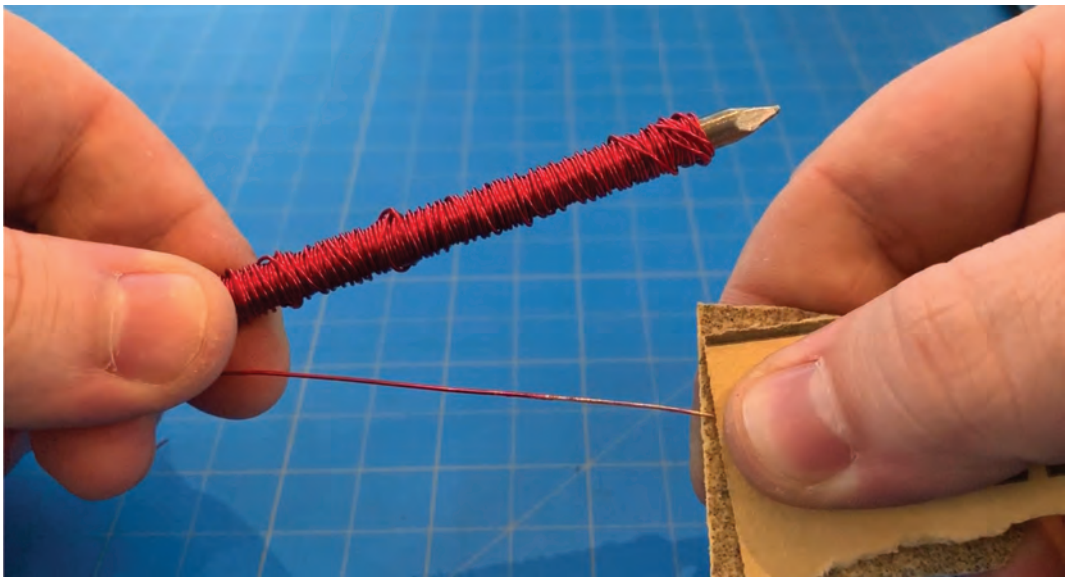


Now wrap it all the way back down the nail so that both ends of the wire end up in the same place.

Part 5: Adding More Coils



Cut off the end of the wire from the spool.

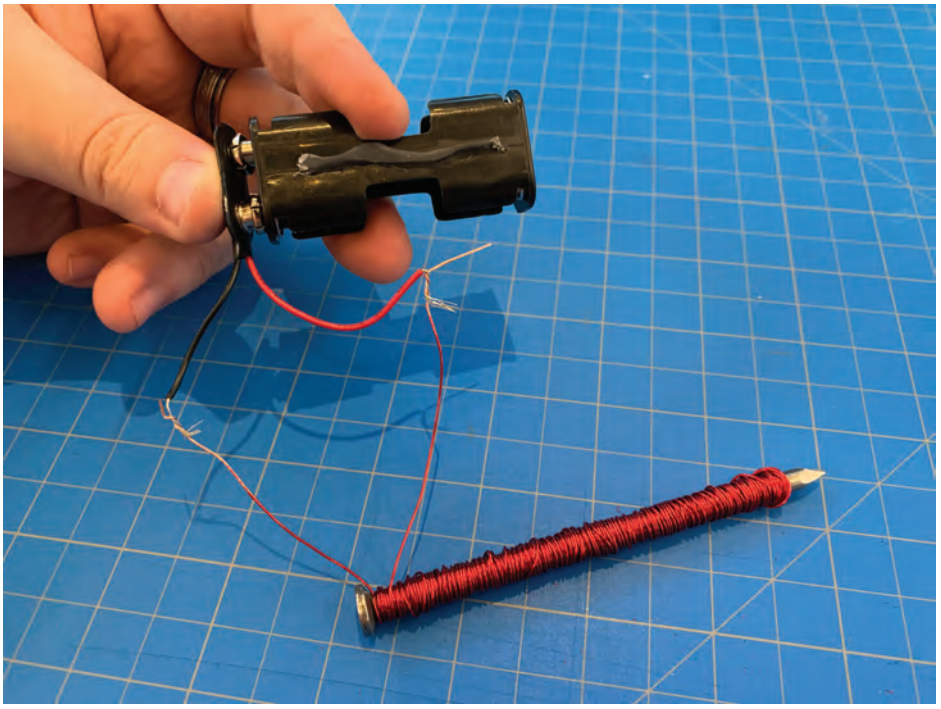


Sand down the ends of the wires.

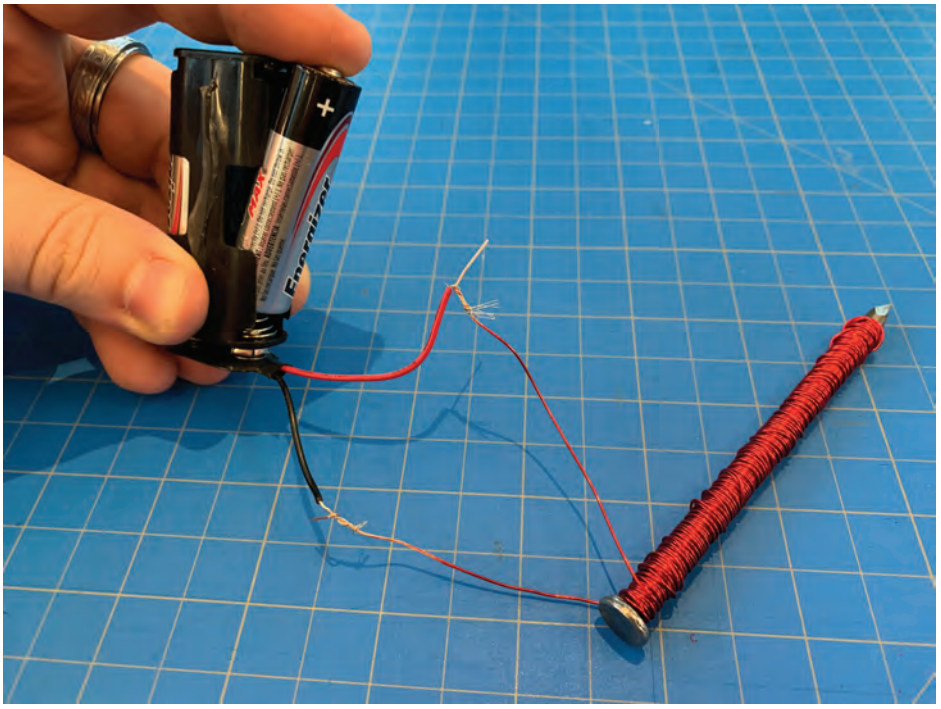
WARNING!

Before you connect your batteries to the wires, you should know that the nail and the batteries can get very hot. You should only keep the magnet plugged into the batteries for 20 seconds at a time. If they start feeling too hot, unplug the battery connector so things can cool.

Part 6: Adding the Battery & Testing

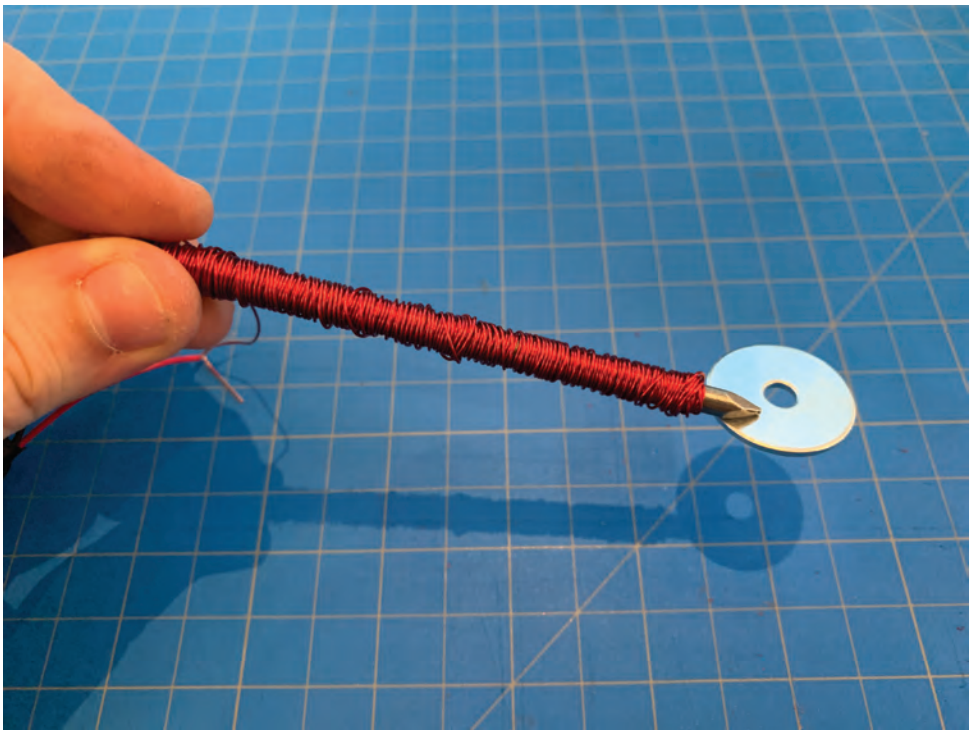


Attach the wires to the battery pack connectors.

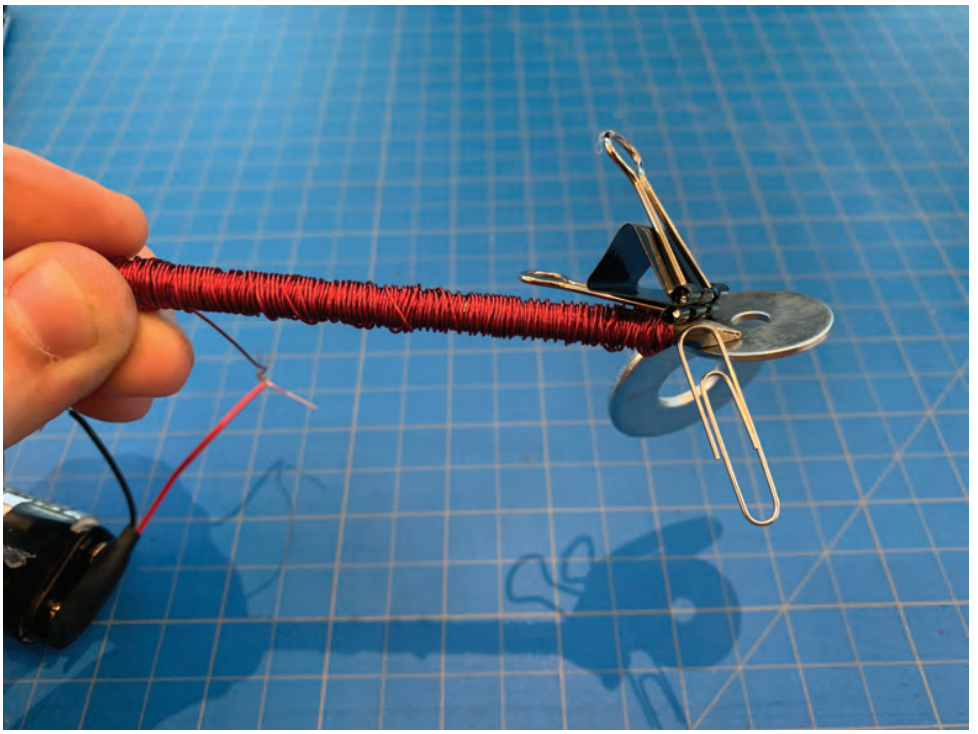


Add the batteries back to the pack if you took them out.

Part 6: Adding the Battery & Testing



Try picking up something with the end of the nail. Does it feel stronger than the first magnet?



How many things can you pick up with the end of your magnet?

Part 7: Reflection and Discussion Questions

Do you feel like you understand how your magnet works? What needs more explanation?

Why might it be useful to have a magnet that you can control with electricity?

What do you think would happen if we added more powerful batteries to the magnet?

Compare your magnet with a friend's. Did your friend do anything different from you? What happens when you bring the ends of your magnets together?