Lesson Plan

Lesson Name: Paper Clip Motor

Grade Level Connection(s):

- NGSS Science and Engineering Practices
    - 4-PS3-2: “Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.”
    - 4-PS3-4: “Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.”
- Disciplinary Core Ideas
    - PS3.B: Conservation of Energy and Energy Transfer – “Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.”
- Crosscutting Concepts
    - 4-PS3-2/4: Energy and Matter - Energy can be transferred in various ways and between objects.
    - 4-PS3-4: Most scientists and engineers work in teams.

Teaser/Overview

In this activity, students will learn how electric motors work. Students will be introduced to the concepts of energy transfer by assembling a motor that converts electric energy to rotational energy.

Lesson Objectives

Students will:

- Explore how magnets have poles
- Learn about magnetic fields
- Build an electric motor

Vocabulary/Definitions

- Magnet
- Magnetic field
- Motor

Materials:

- Magnet wire (green or red coat work best since students can see contrast after sanding)
- D cell batteries

- C cell batteries
- Magnet
- Paperclips
- Popsicle sticks
- Sandpaper
- Rubber bands
- pennies

Classroom Set-Up

- Before class:
    - Print instruction pages
    - Cut wire to length (~35in), 1 per student
- Students should be arranged into groups of 4. One kit goes to each group.

Classroom Visit

1. **Introduction** (10 minutes)
    - Who are we as a group?
        - ASHRAE
    - Role model introduction
        - Why did you become an engineer?
        - How did you get to where you are?
        - What do you do with your job?
        - What hobbies do you have?
    - Topic Introduction
        - What do you know about magnets?
        - What is a motor? Some examples?
        - What is electricity?

2. **Learning Experience**

- How does a motor work (PowerPoint slides)
- Have the students sketch out how they would create a motor. What components will they need?
- Assemble the electric motor (PowerPoint slides)

3. **Wrap-Up: Sharing Experiences**

    Questions to ask the whole class
    - What do you need to create a motor? What does each component do?
        - Each group can say one component

4. Connections & Close

Questions to ask class:

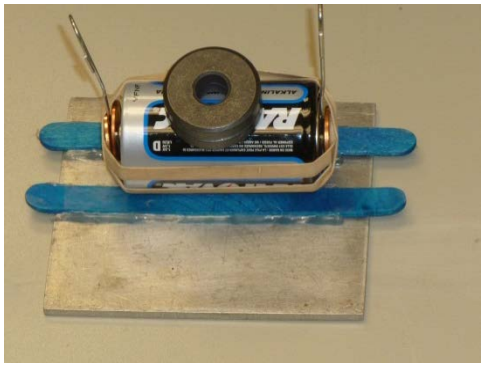
- How can you make the motor go faster?
- What could you use the motor for?

Materials

- Magnet wire (green or red coat work best since students can see contrast after sanding) (315-Ft. Magnet Wire Set, http://www.radioshack.com/product/index.jsp?productId=2036277
- D batteries
- C batteries or 1in PVC tube
- Magnet (Home Depot)

Volunteer (10 –15 min / person)

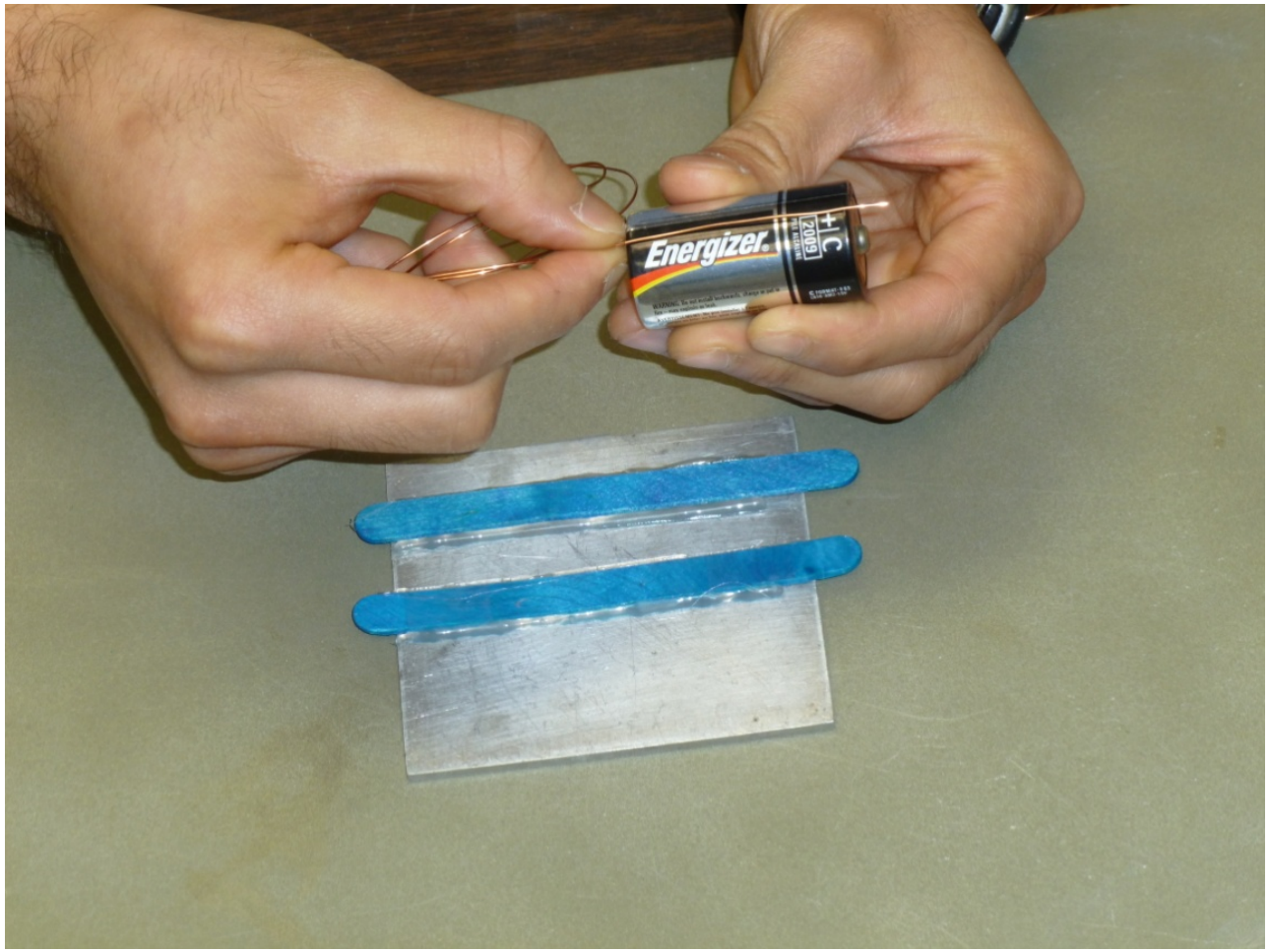
- Make coil for troubleshoot experience.
- Transport materials
- Strive for 3-4 students / volunteers



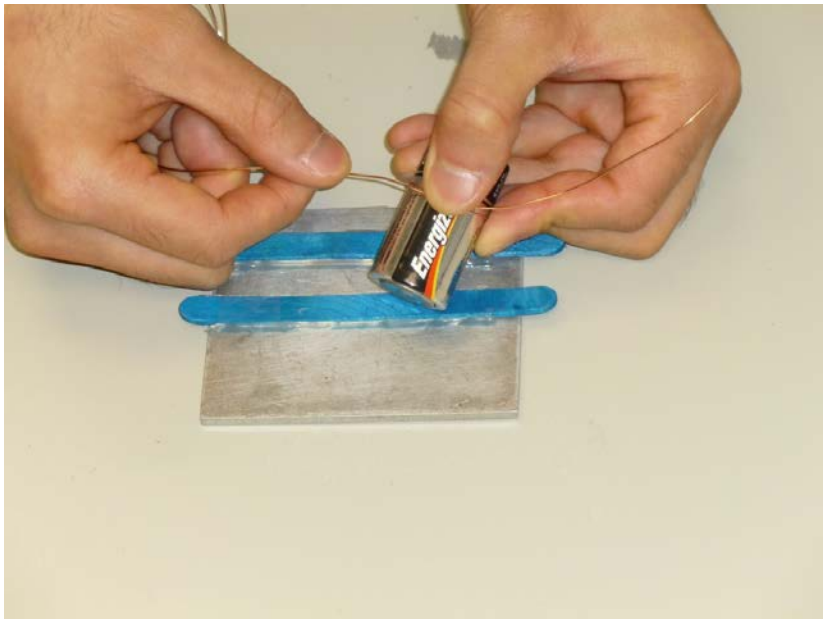
Before the activities: Set up station (1.5-2h)

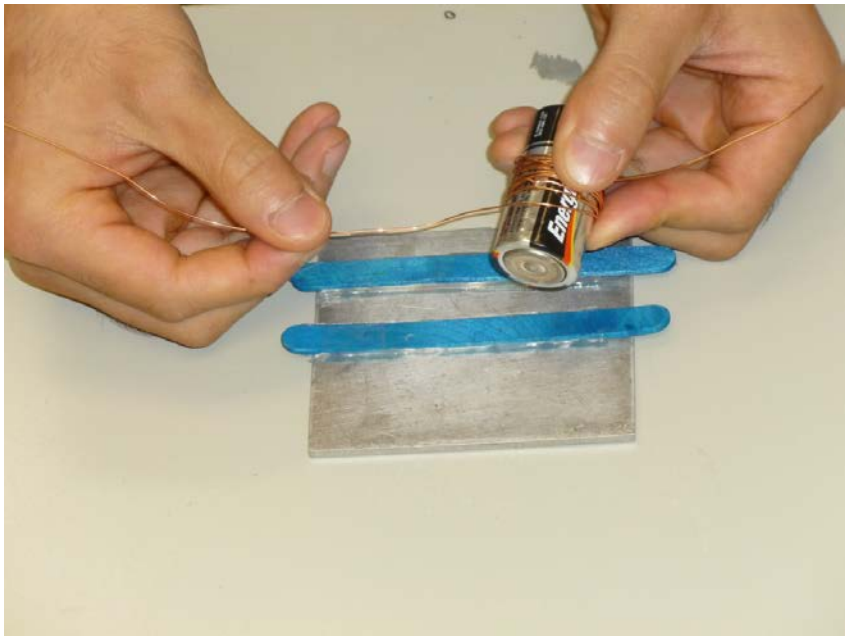
- Print instructions pages
- Cut wire to length (~35in)
- Stations with: D battery + paper clip, 3 C batteries (for wrapping), sanding surfaces (aluminum/ plastic plates, avoid cardboard b/c it is flimsy)
- Troubleshooting box: scissors, multimeter, rubber bands, pennies

MEASURE ONE BATTERY LENGTH OF WIRE

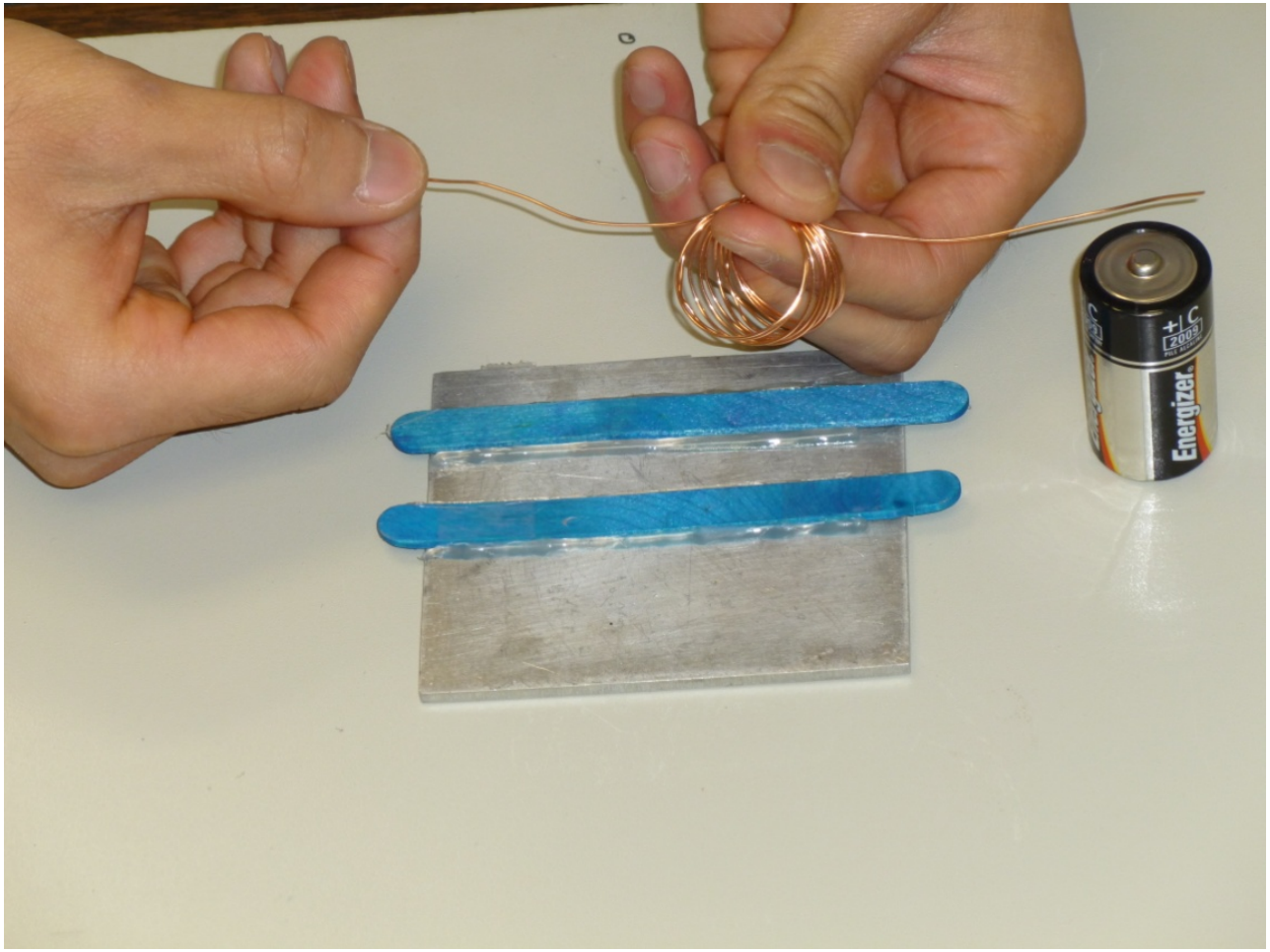


BEGINNING FROM MEASURED LENGTH, WRAP 10 TIMES AROUND THE BATTERY

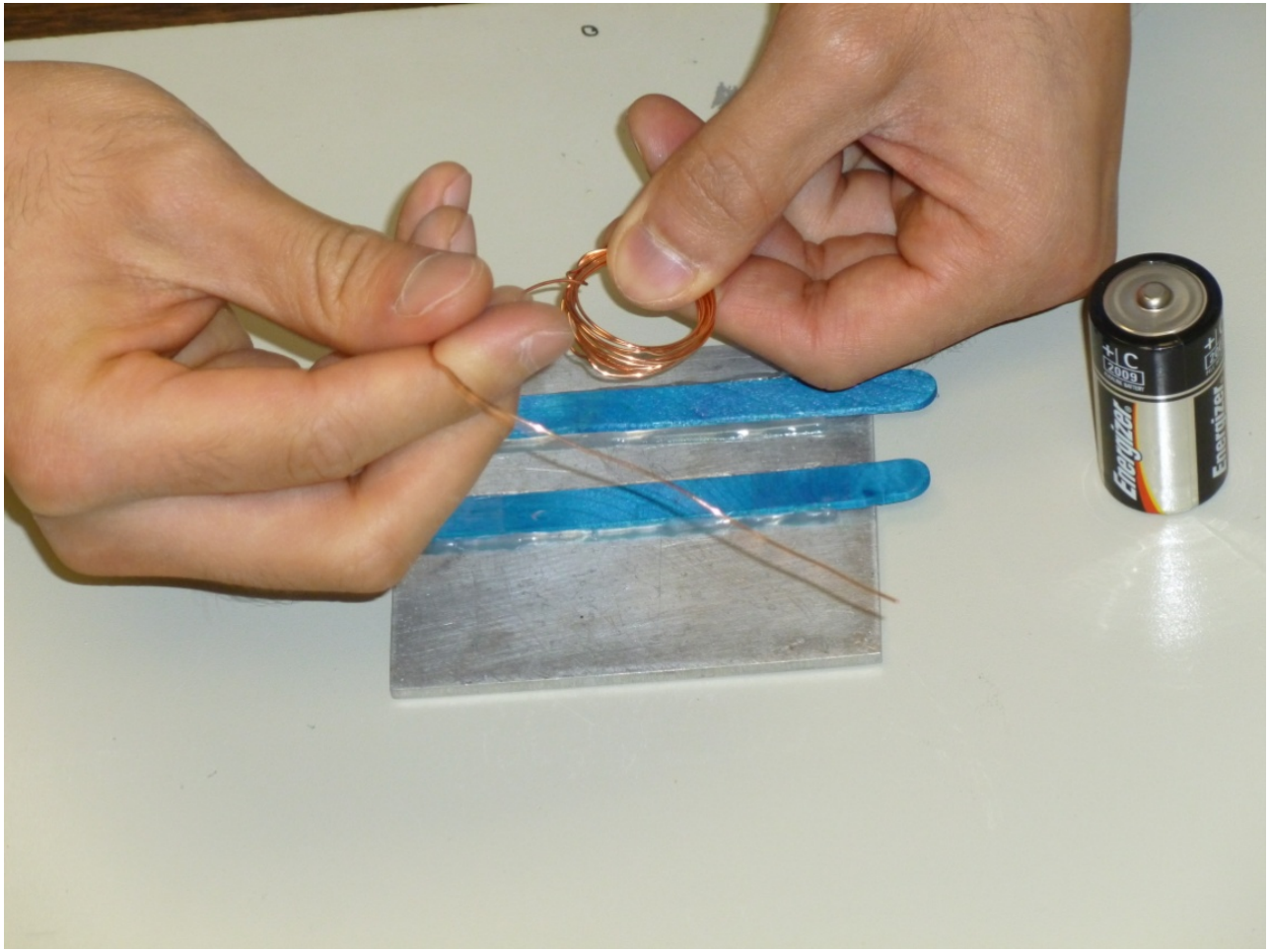




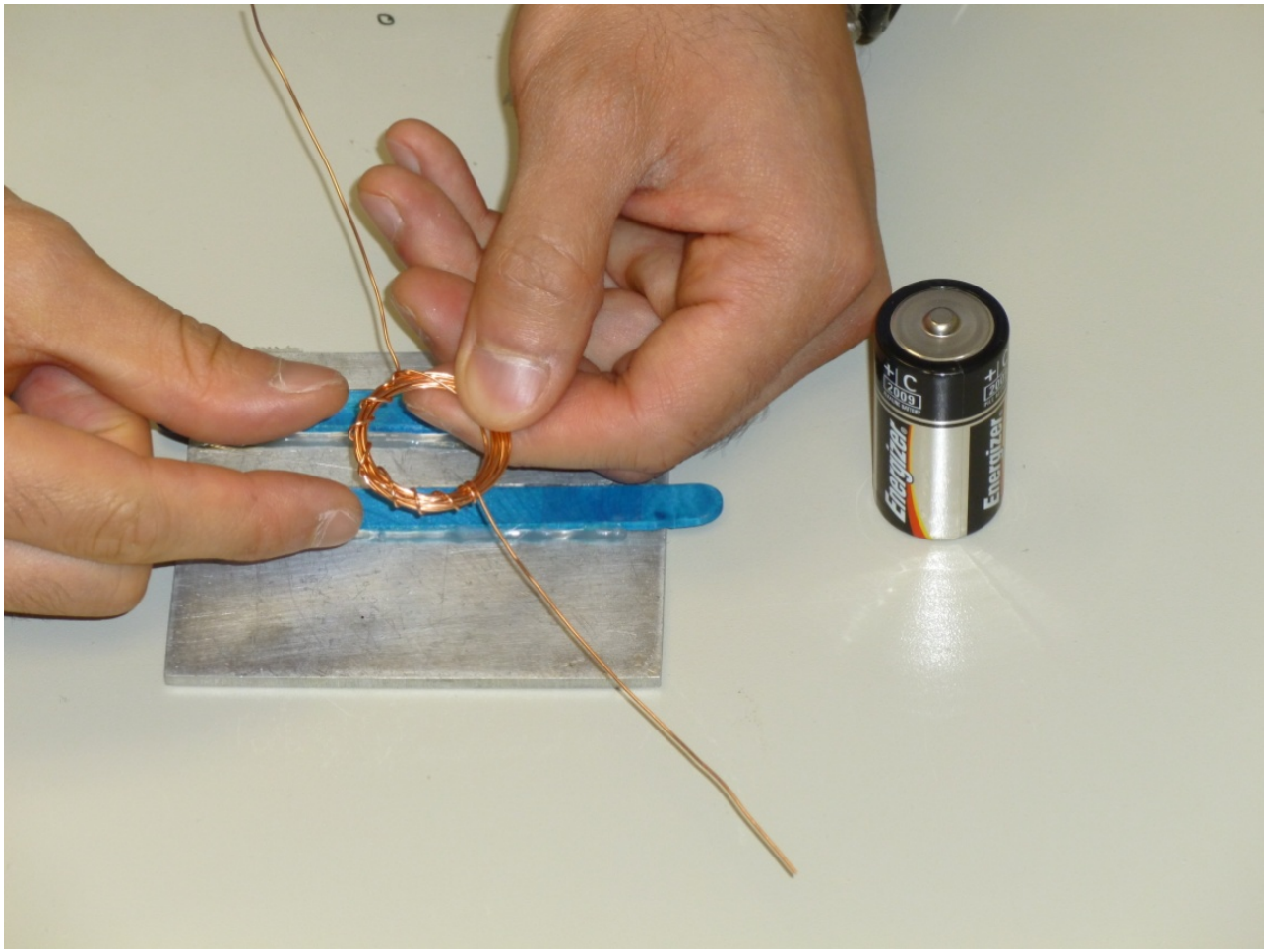
REMOVE BATTERY BUT KEEP THE COIL PINCHED TOGETHER



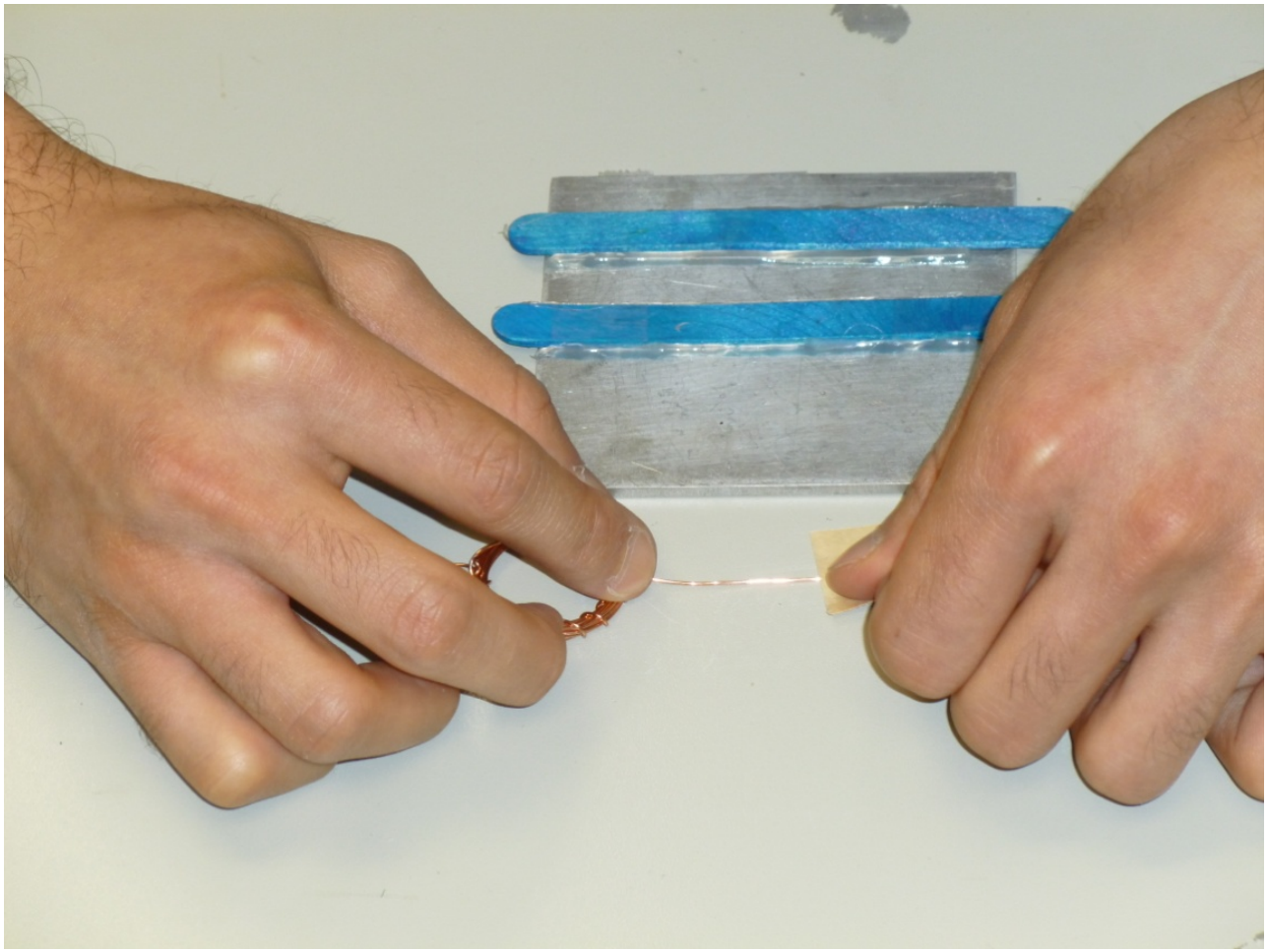
WRAP LONGER END AROUND THE COIL ITSELF



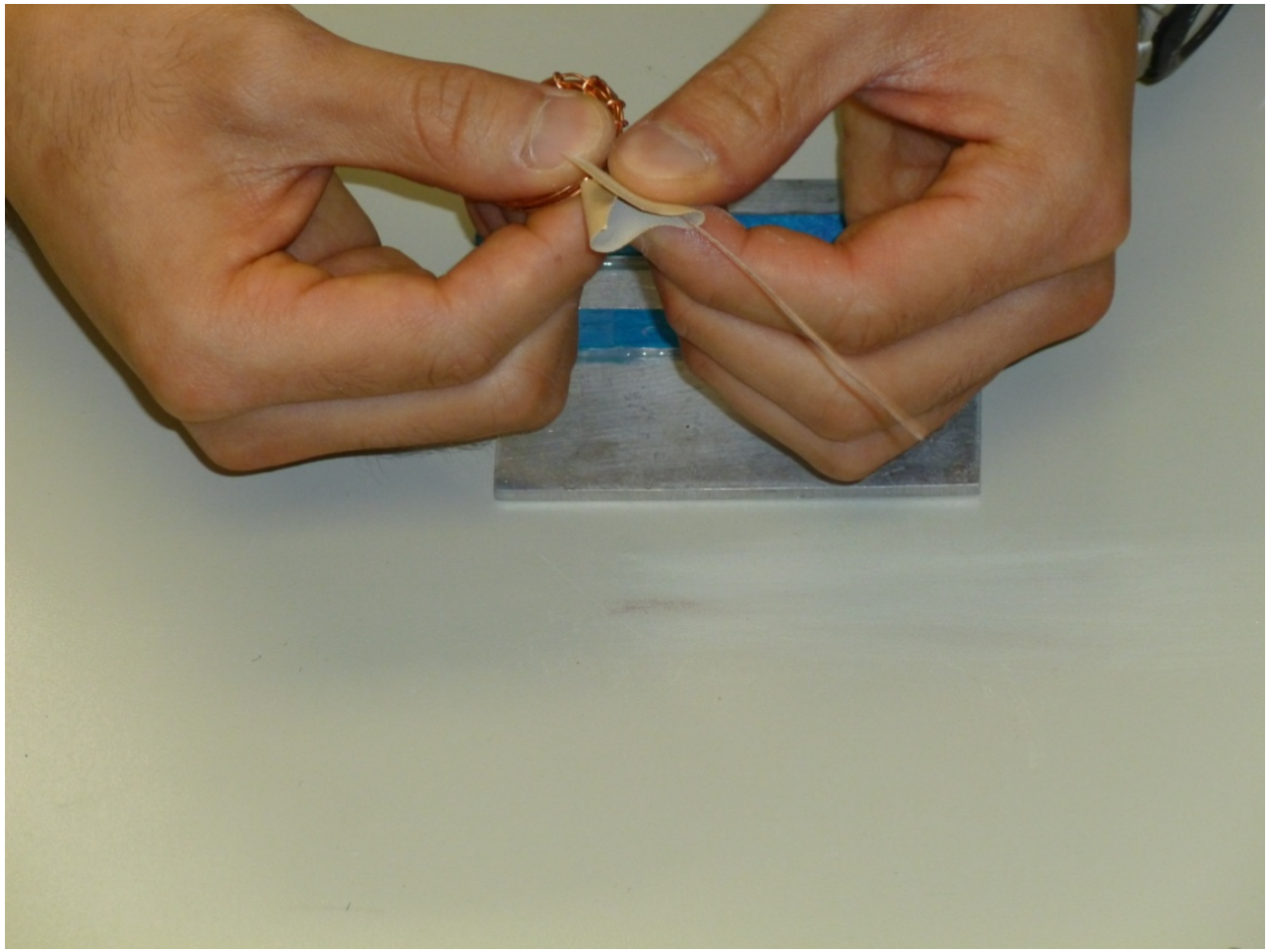
WRAP UNTIL ENDS ARE OPPOSITE EACH OTHER



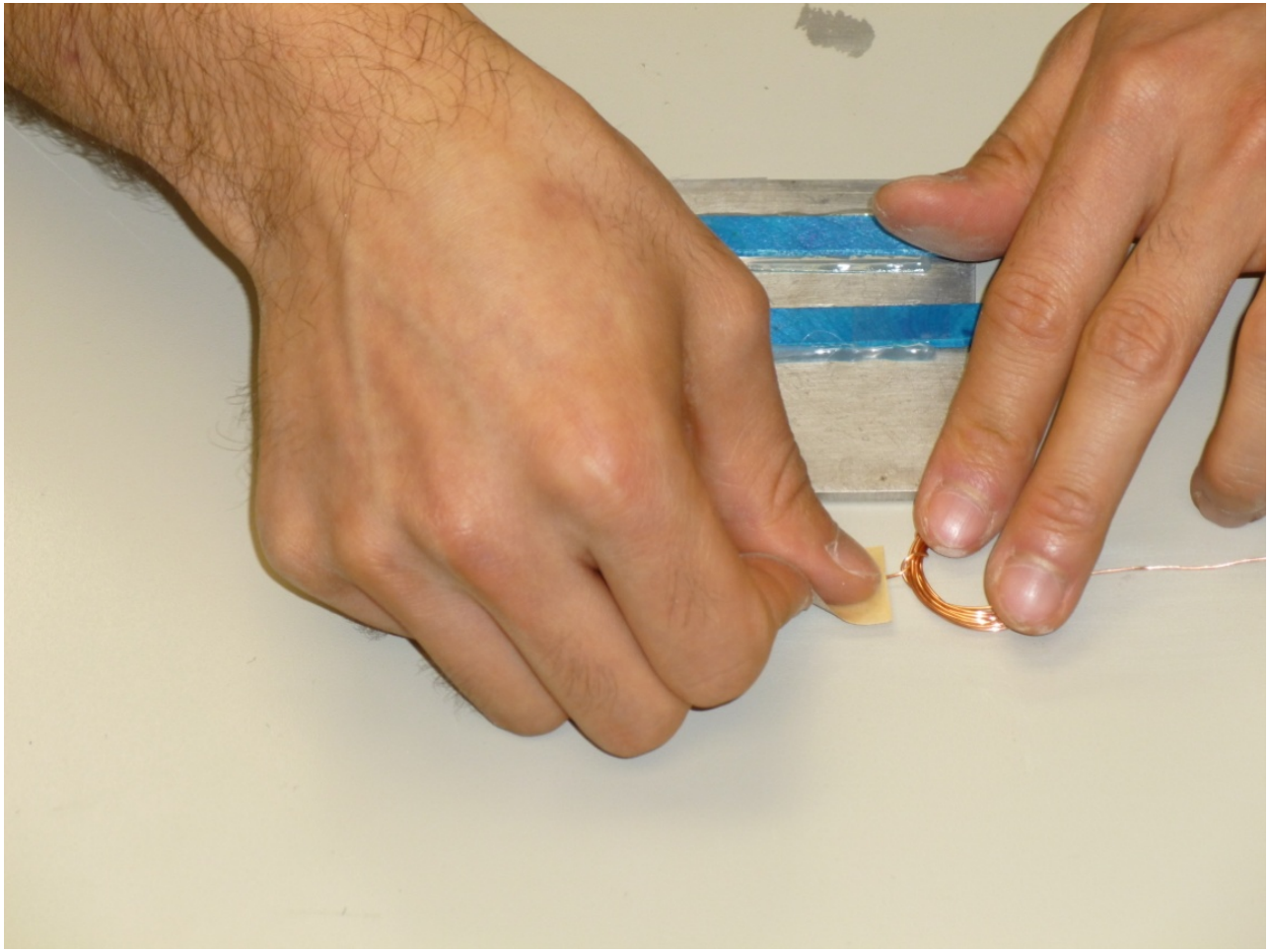
SAND TOP SIDE OF FIRST END



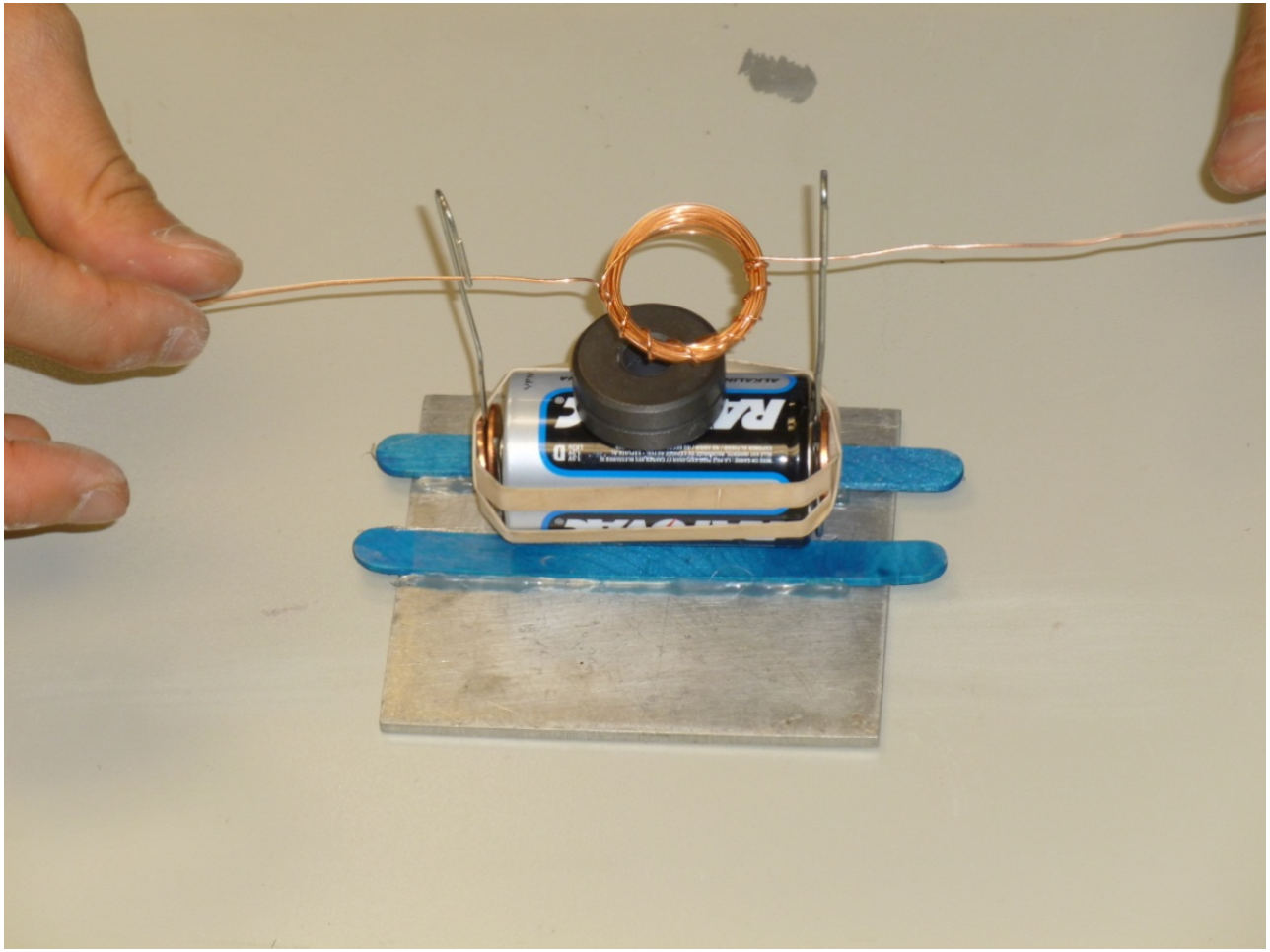
SAND BOTTOM SIDE OF FIRST END TOO



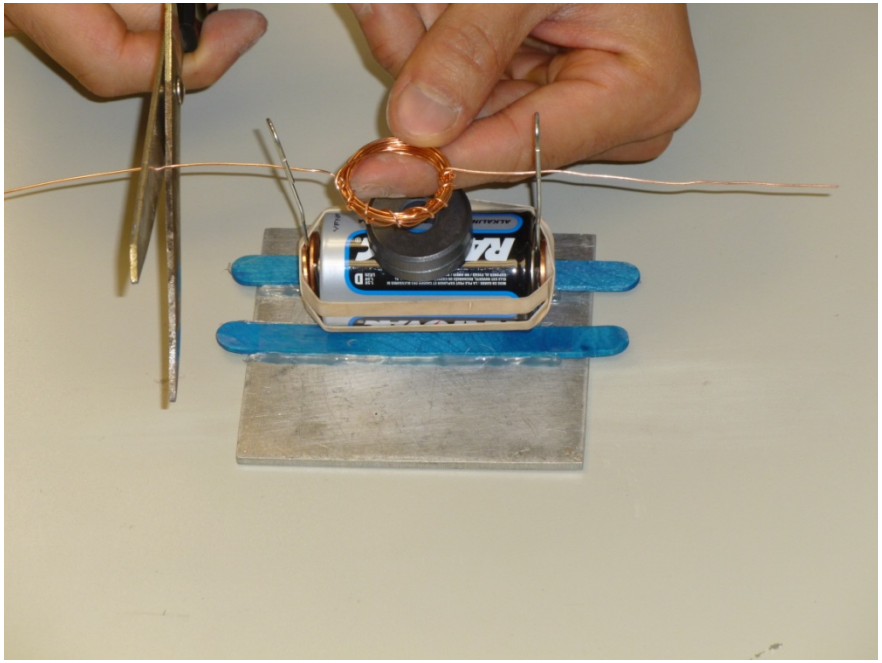
SAND ONLY ONE SIDE OF THE SECOND END

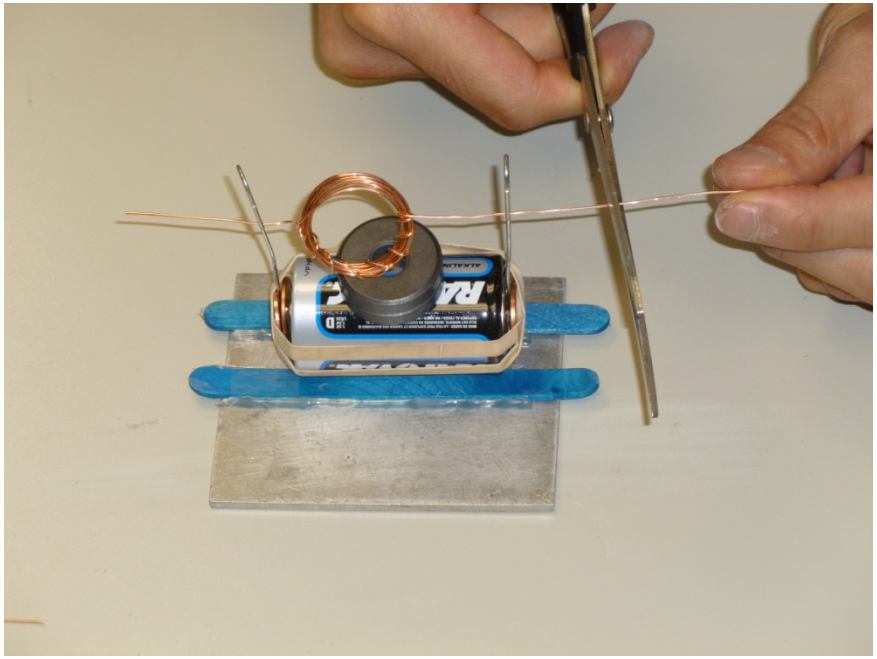


PLACE COIL ON PAPER CLIP HOOKS AND MAKE SURE IT IS HORIZONTAL TO THE BATTERY

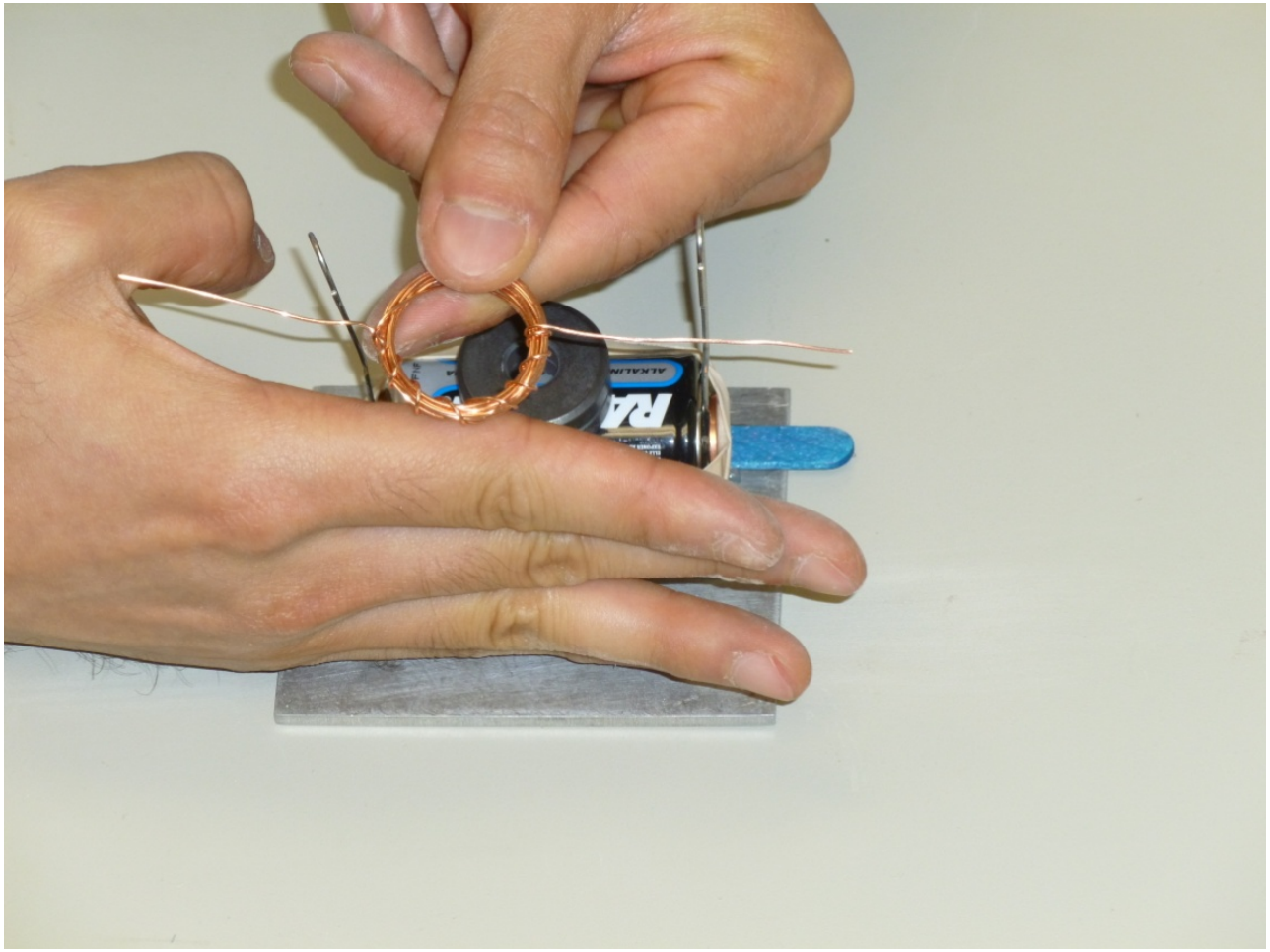


TRIM BOTH ENDS





MAKE SURE YOUR WIRE IS STRAIGHT



GIVE A GOOD TURN ON ONE END & WATCH IT GO!