Electromagnetism

Vanderbilt Student Volunteers for Science

Training Presentation

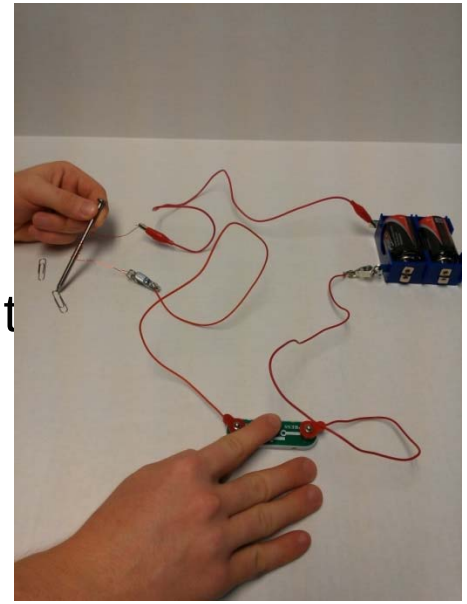
2018-2019 VINSE/VSVS Rural

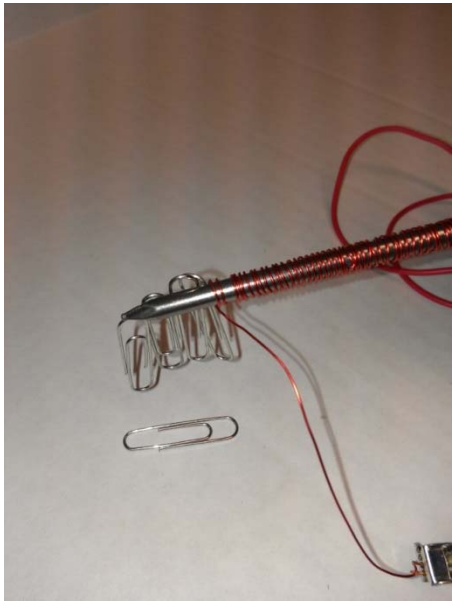
I. Introduction

- Ask students what they know about magnets.
  - All magnets have two poles.
  - Same poles repel each other, but opposite poles attract
  - Magnets all have a 3-D magnetic field surrounding.
- Ask students what they know about electromagnets
  - Electromagnets are made by wrapping wire around a core and passing current through that coil
  - The more coils there are, the stronger the magnetic force
  - They differ from permanent magnets in that they are temporary

II. Making an Electromagnet Using Batteries, a Nail and Copper Wire

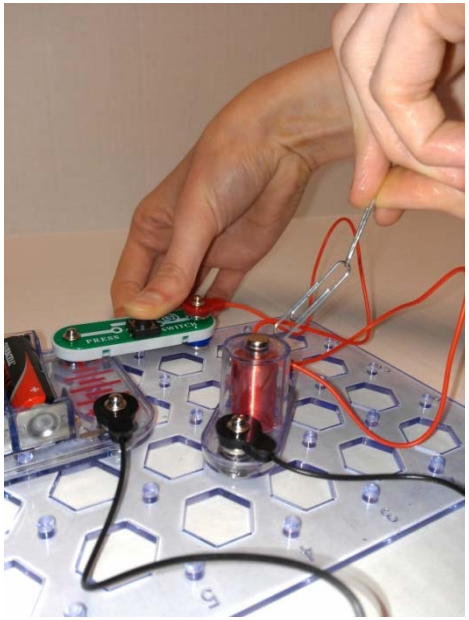
- Students should observe that the two nails, when not connected to the circuit, will not attract paperclips
- Students will make the circuit as shown
- They will see that when the circuit is completed, the nail with fewer coils is not even able to pick up one or two paperclips
- Students will remake the circuit using the nail with 50 coils, and they should see that it is able to pick up many more paperclips

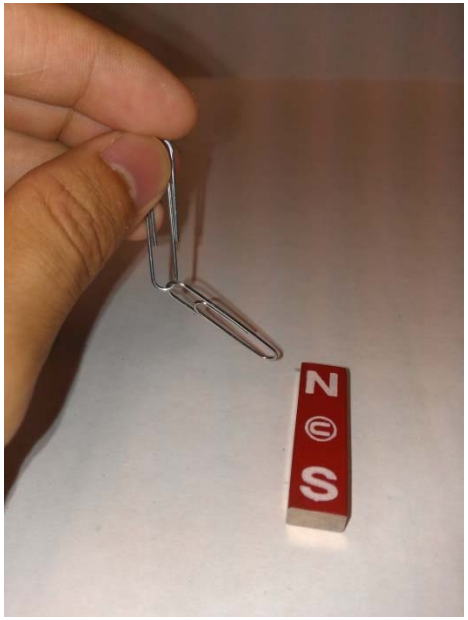




III. Comparing Properties of Magnets and Electromagnets

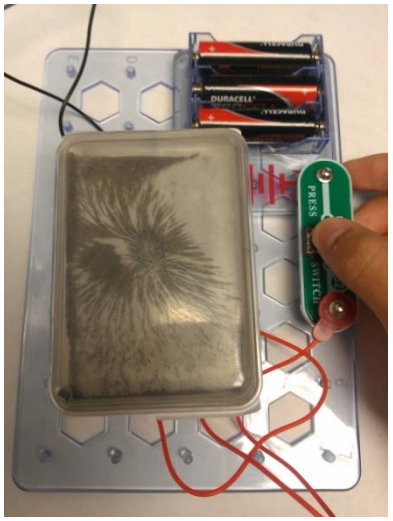
- Students will test the strength of the magnet by using 2 paperclips looped onto another and hanging them next to the magnet to observe attraction and field
- Compare this to what occurs when the same paperclip loop is held next to the electromagnet
- An electromagnet is made by passing current through a coiled wire.
- Students should construct the circuit shown in the middle picture. Be aware there's a #1 connector under the switch.





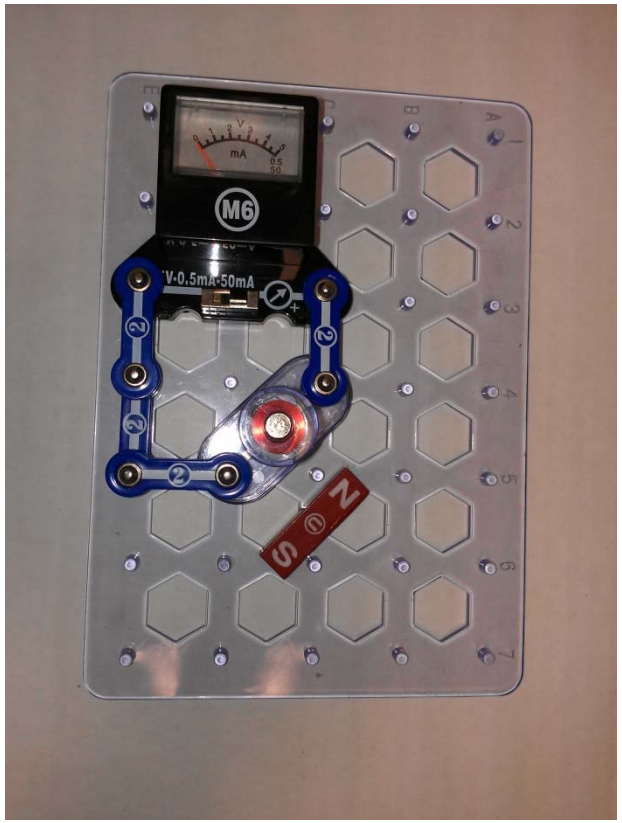
III. Comparing Properties of Magnets and Electromagnets (cont.)

- Students use iron filings to visualize the magnetic field by placing a container of iron filings on top of a bar magnet and gently shaking the container
- The denser the lines, the stronger the field at that point in space.
- They then test the field of the electromagnet.
- The shape of the field is the same as the bar magnet.

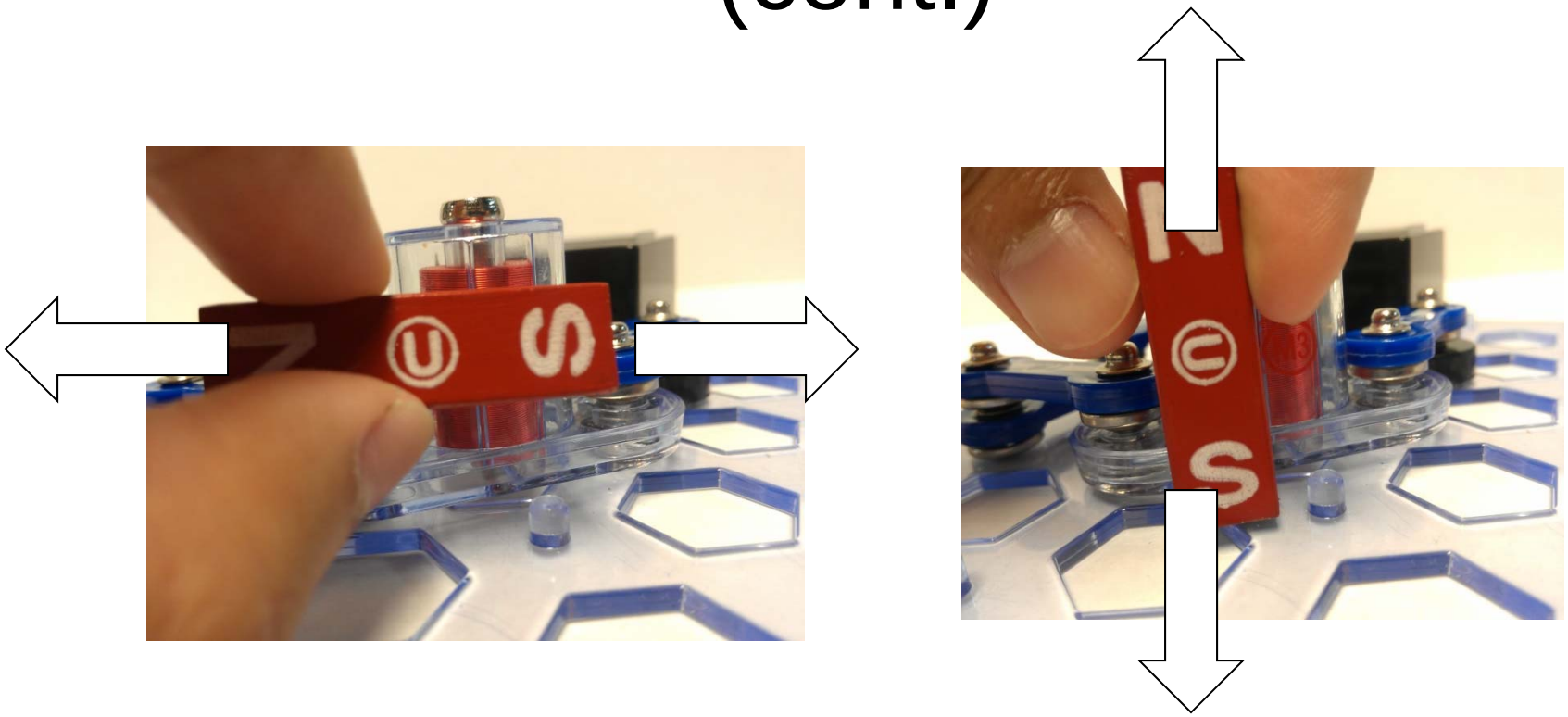


IV. Making Electricity with Magnets

- Students will construct the electrical circuit as shown – leave the iron core out of the coil at the beginning.
- The meter should be set to the **middle** mA setting.
- The board should be flat on a table so that small movements will be visible.
- Students should observe the meter needle as they move the magnet both with and without the core. *Needle movement indicates current moving in the circuit.*



IV. Making Electricity with Magnets (cont.)



- Move the magnet both horizontally and vertically past the copper coil, as shown.
- The movement of the magnet induces current in the copper coil.

V. Using a Motor to Make a Generator

- Electric motors operate by using current through a coil to turn a magnet.
- Use the given circuit, and *gently* turn the motor with a finger.
- Changing direction changes the direction of the current.
- This is a conversion from mechanical to electrical energy.

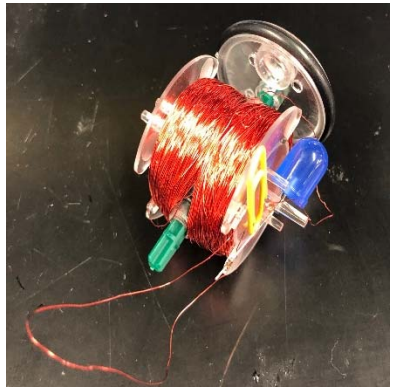
V. Making Electricity with Magnets and Coil

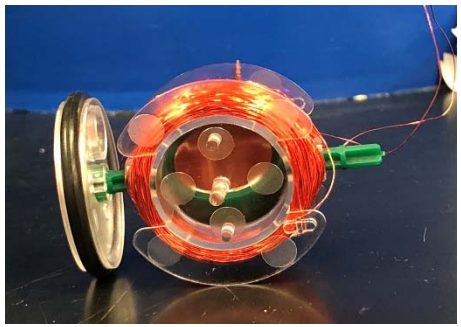
Learning Goals: Students know that an electric current can be induced by using a magnet and a wire.

Give each group a generator’

Tell them to identify the different

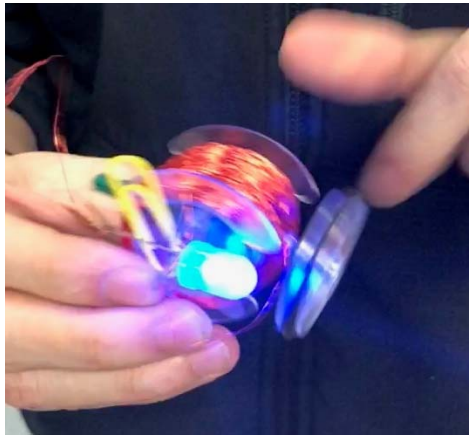
parts – magnet, LED, coil, spindle.





V. Making Electricity with Magnets and Coil cont.

- Ask students to identify what happens when the spindle moves (it rotates the magnet). Students should twirl the spindle with a finger, Do not let them run the wheel on the desk.
- What happens when you turned the spindle of the transparent generator SLOWLY? (nothing)
- What happens when you turned the spindle of the transparent generator FASTER? (the LED lights up)



IV. Applications of Electromagnets contd.

Explanation:

We know that an electromagnet has a magnetic field when an electrical current flows through it. Magnets also have permanent magnetic fields. The 2 magnetic fields can attract or repel each other.

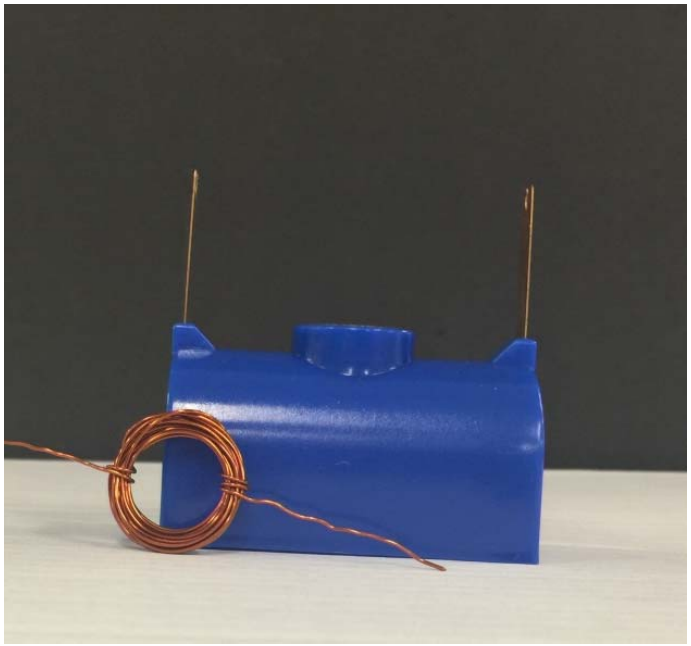
- The motor works because electricity flows through the coil and a magnetic field is formed. The magnetic fields from the magnet and electromagnet repel each other.
- The coil pushes away from the magnet with enough force to turn it around. As the coil rotates around, the coated side makes contact with the copper supports and breaks the electrical circuit.
- Momentum carries the coil around to its starting position, when the stripped wire now comes back into contact with the copper supports.
- The circuit is again completed, so the magnetic field in the electromagnet is created again, and the coil continues to spin.

Motors are commonly used to convert electricity to mechanical energy.

IV. Applications of Electromagnets – Using Electricity and an Electromagnet to Make a Motor

Learning Goal: Students can give examples of everyday uses of electromagnets.

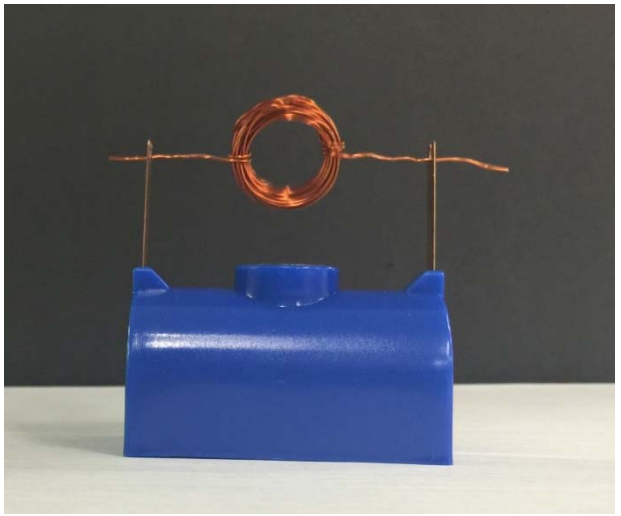
- Tell students to look at the motor and identify the following parts: a permanent magnet, an electromagnet. copper wire, and a battery.
- Point out the copper supports that connect the battery to the coil.
- Point out that the copper wire is covered with an enamel coating for insulation. Tell students to look closely at the 2 straight ends of the copper coil. Both ends have had the enamel coating stripped from one side of the wire (it does not have the same shiny copper color as the other side). The coated side will not conduct electricity, whereas the stripped side will allow a current to flow through the coil.



IV. Applications of Electromagnets contd.

Tell students to:

- Place the straightened wires from the coil into the U of the copper supports. The shiny (insulated) side must be facing UP.
- Give the coil a gentle tap. If it spins continuously, the student has succeeded in making a motor.
- If the coil does not spin, have the student tap it in the other direction.

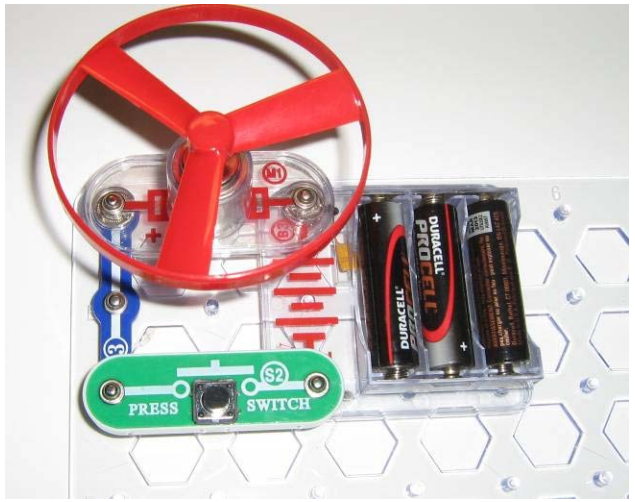


Optional:

- Flip the magnet over (so that a different pole will now be facing up). Repeat steps 1-3. What happens?

VI. Using Electricity to Run a Motor

- Alternatively, electricity can be used to power a motor.
- Students build the circuit shown.
- Without the fan, notice that pushing the switch turns the motor.
- With the fan blade, doing the same launches the blade.
- This is a conversion from electrical to mechanical energy.



Clean Up

- Have the students reassemble the circuit components the way they received them.
- Make sure all circuit components are collected and packaged properly.
- Place the grids between the sheets of bubble wrap.
- Return all supplies to the VSVS lab.