FEMMES Capstone Activity!
Making an Electromagnet

INSTRUCTOR GUIDE

Key Concepts: Magnets, electromagnetism, magnetic field

Goals for student learning: This activity will teach the students about magnets. The students will learn about the properties of magnets, how magnetic fields work, which metals are magnetic and which aren't, how to build an electromagnet, and much more!

Time: 30 minutes

Materials

- A large iron nail (about 3 inches)
- About 3 feet of THIN COATED copper wire
- A fresh D size battery
- Some paper clips or other small magnetic objects
- Some wooden toothpicks
- Insulating dough
- Masking tape

Introduction: What are Magnets?

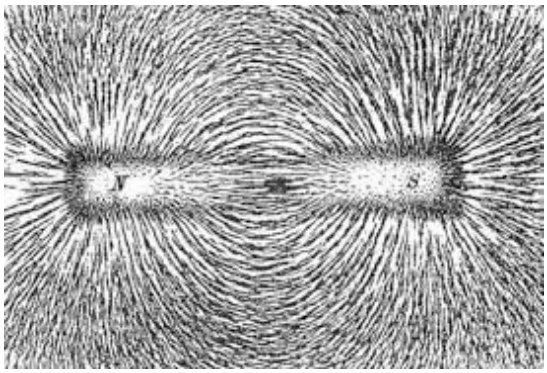
Before beginning the activity, your student(s) will learn about magnets: how they work, why they're important, how they're activated etc. Below is a selection of questions (and their answers) that Activity Leaders may elaborate on.

If conducting the activity yourself, feel free to improvise! It is best for students to work in teams of two during this portion (conditions like online instruction may affect the grouping).

Q: What is a magnet?
A: A magnet is a material that produces a force that attracts metals like iron or steel. They exert control over another object without touching it! There are a lot of metals that are not attracted to magnets, such as copper, silver, gold, magnesium, platinum, aluminium and more. There are different types of magnets. A magnet can be permanent (always display characteristics of magnetism) or temporary (can be turned on/off). At some point tell the students that the rectangle magnets at their workstation are permanent and that the electromagnets that they will be making are temporary. Magnets do not come in only one shape or size. They can be made in a variety of shapes and sizes. They can be really big or really small.

Q: What are the characteristics of a magnet?

A: All magnets have 2 poles (a North pole and a South pole). Opposite poles attract and same poles repel. All magnets have a 3 dimensional field of attraction, in other words, they produce an area of magnetic force called a magnetic field. Magnetic fields by themselves are invisible to the human eye. You can demonstrate the magnetic field/lines of flux around the magnet with the small compass or iron filings (see images below), and have the students use the compass to identify the North and South poles. Have the students play with two of the permanent rectangle magnets to feel the attraction/repulsion. Have students demonstrate the North/South pole attraction by having one student slowly bring the North Pole of her magnet to a nearby student's South Pole of his magnet. Have the students slowly bring together North Pole to North Pole and South pole to South pole to experience them repel.



other illustrations of magnetic attraction on final page

Q: Where does magnetism come from?
A: Magnetism can occur in nature (the earth's magnetic field extending from north and south pole), can be man-made (ceramic, Alnico, flexible rubber-like material), or can be created using current (electricity).

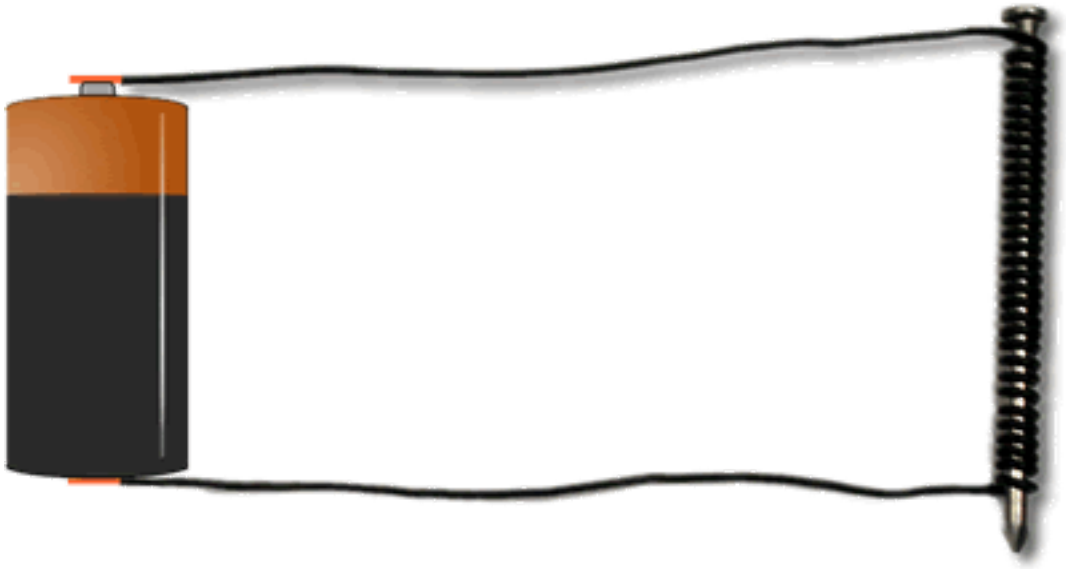
Q: What will the magnet pick up? Will it pick up a toothpick? A paperclip?

A: Each group has 2 magnets, paper clips and toothpicks. Have the students use one magnet to determine whether it will pick up a toothpick or a paperclip. Have the students determine how many paper clips they can pick up with one magnet. After they have determined the number they can pick up, ask them to predict the number of paper clips they could pick up with 2 magnets. Have the students tell you their prediction and then perform the activity. Discuss how it is possible to increase or decrease the strength of the magnet.

Q: Do we need magnets? What do we use magnets for?
A: Uses for magnets in everyday life include: in cars (power locks), at home (door bell, microwave, TV, refrigerator, earrings, electricity), in school (whiteboards), in medicine (MRI). Other examples include the magnetic strip on credit cards, compasses commonly use the earth's magnetic field, many toys use magnets…

Activity Time!

Now have the students make an electromagnet. First, explain what an electromagnet is. There are two parts to the word. First, electro, which sounds like electricity, and *magnet*, which is what it sounds like — a magnet! So, an *electromagnet* is a magnet that is created by electricity. They run on electricity and are only magnetic when the electricity is flowing. Therefore, electromagnets are temporary magnets because you can turn them on and off. Electricity can create a *magnetic field.* This may sound strange, because we're used to magnetic fields just coming from magnets, but it is really true! A wire that has electric *current* running through it creates a magnetic field. In fact, the simplest electromagnet is a single wire that is coiled up and has an electric current running through it. The magnetic field generated by the coil of wire is like a regular bar magnet. If we put an iron rod (perhaps a nail) through the center of the coil (see premade example), the rod becomes the magnet, creating a magnetic field. Where do we find the electricity for an electromagnet? For this experiment, we will get this electricity from a *battery*.



Example of an electromagnet

Making an electromagnet

Step 1: Have the students wear gloves. Leaving about 4-6 inches of wire loose at both ends, wrap the copper wire around the nail. Try not to overlap the wires.

Step 2: Remove about an inch of the coating from both ends of the wire with sandpaper and attach one end of the wire to the positive end of the battery and the other end of the wire to the negative end of the battery. Have the students tape the wires in place.

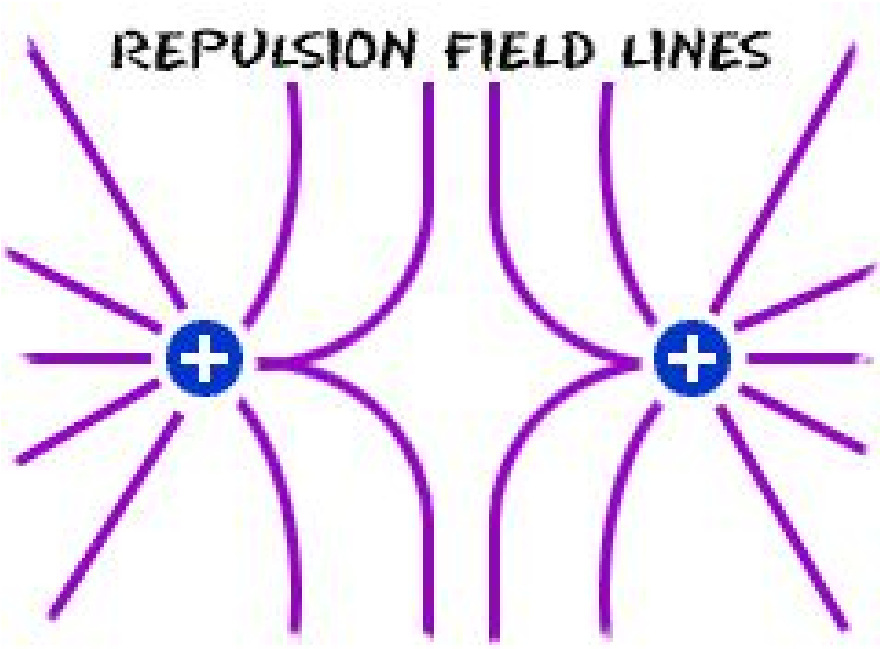
SAFETY NOTE:** the wires/battery can get very hot! Have the students cover the tape on both ends of the battery with insulating dough in order to protect their fingers from the heat. NEVER get the wires of the electromagnet near a household outlet! Be safe - have fun!

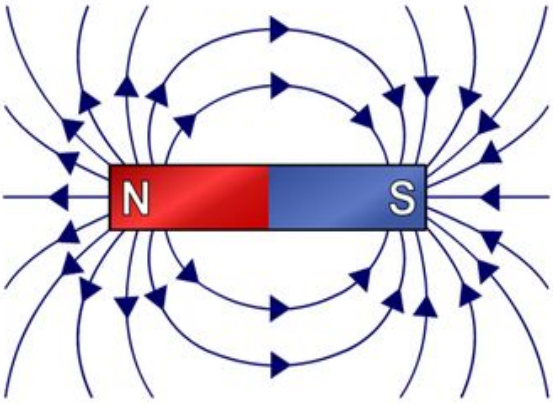
Step 3: Now you have an ELECTROMAGNET! Put the point of the nail near a few paper clips and it should pick them up! The electricity flowing through the wire arranges the molecules in the nail so that they are attracted to certain metals. Does the number of times you wrap the wire around the nail affect the strength of the nail? Does the thickness of the wire affect the power of the electromagnet?

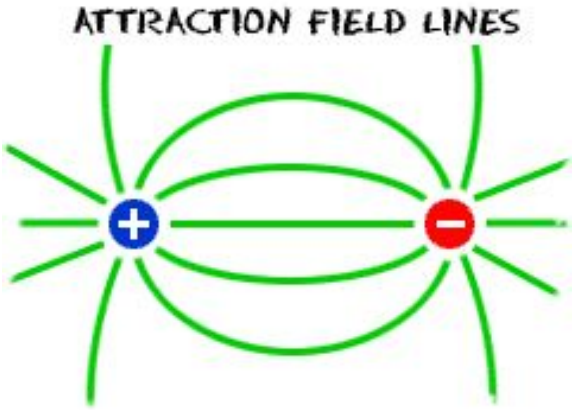
There are a few ways to make this magnetic field stronger — we can increase the amount of electric current going through the wire (bigger battery…that we don't have) or we can increase the number of wire wraps in the coil of the electromagnet. What do you think happens if we do both of these things? That's right! Our magnet will be even stronger!

Engineers use electromagnets when they design and build *motors*. Motors are around us everyday, so we interact with electromagnets all the time without even realizing it! Can you think of some motors that you have used? (Possible answers: Washing machine, dishwasher, can opener, garbage disposal, sewing machine, computer printer, vacuum cleaner, electric toothbrush, compact disc [CD] player, digital video disc [DVD] player, VCR tape player, computer, electric razor, an electric toy [radio-controlled vehicles, moving dolls], etc.)

NOTE: Making an electromagnet uses up the battery somewhat quickly which is why the battery may get warm, so disconnect the wires when you are done exploring.




N
S


ATTRACTION FIELD LINES

References:

http://www.sciencebob.com/experiments/electromagnet.php

http://www.teachengineering.org/collection/cub_/activities/cub_mag/cub_mag_lesson2_activity1_electromagnet_worksheet.pdf

http://www.teachengineering.org/collection/cub_/activities/cub_mag/cub_mag_lesson2_activity1_electromagnet_worksheet_answers.pdf

http://www.instructables.com/id/5-Minute-DIY-Motor/?ALLSTEPS

https://www.srpnet.com/education/pdfx/magnetism.pdf

http://www.sciencekids.co.nz/sciencefacts/magnets.html

http://www.physics4kids.com/files/elec_magneticfield.html