PhyzLab: Electric Magnetism

using electricity to create magnetic force

PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Purpose •

In this activity, you will investigate magnetic forces created by electric currents and a practical application of those forces.

• Apparatus •

___ bar magnet •
___ Genecon hand generator
___ wire coil •
___ wood dowel •
___ iron core •
___ field coil (from St. Louis Motor kit)

1. PICK UP THE PIECES

In this activity, you will try to use electricity to make a magnet.

a. Put the paperclips in a small pile. Use a bar magnet to lift them, then return them to the pile.

b. Can you lift the paperclips (as you could with the magnet)
   i. using the wood dowel? __Yes __No

   ii. using the iron core? __Yes __No

c. Can you lift the paperclips with the alligator clips of the Genecon wires (as you could with the magnet)
   i. when they are connected but the Genecon **isn't** being cranked? __Yes __No

   ii. when they are connected and the Genecon **is** being cranked? __Yes __No

d. The wire coil and iron core **can** be used to pick up paperclips. Explain how; include a diagram. (Hint: use the Genecon, too.)

e. Can the wire coil and wood dowel also be used to pick up paperclips? ___Yes ___No.

f. Can the field coil from the St. Louis Motor Kit be used to pick up paperclips? (The field coil must be detached from the St. Louis motor for this investigation.) Explain how.

g. In automobile recycling centers (formerly known as junkyards), electromagnets attached to cranes are used to move nonfunctioning vehicles from one place to another. Why use an electromagnet instead of a permanent magnet?

2. MAGNETIC SWING

In this activity, you will explore the interaction between a magnet and a current-carrying wire (again).

___ 2 bar magnets •
___ small wood block •
___ 2 collar hooks •
___ table clamp and support rod
___ right angle clamp and crossbar •
___ connecting wires
___Genecon hand generator
___ 2 rubber bands •
___ ~50cm of solder* (silver wire) •

**solder—pronounced "sodder"—is uninsulated, formable wire: it can be shaped temporarily*

a. Recollection. In *Ørsted's Discovery,* you found that a compass needle could be influenced by current moving through a wire.

i. The needle of a compass is just a small _____.

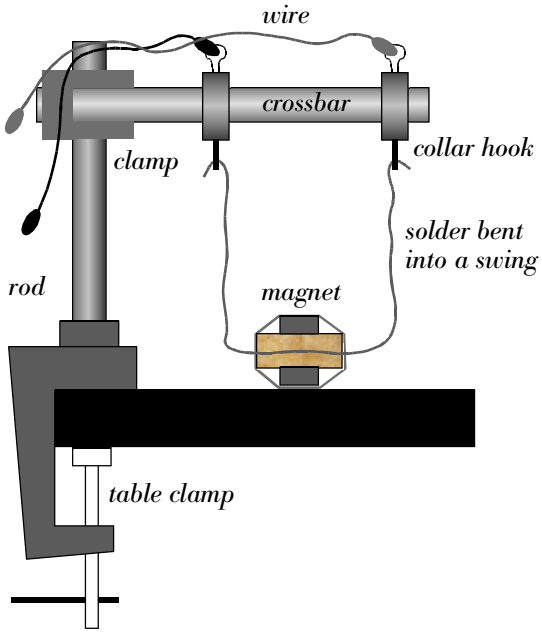
ii. Ørsted discovered that an electric current can exert a force on a magnet. What ***else*** must be happening? (Isaac Newton would hasten to point this out.)

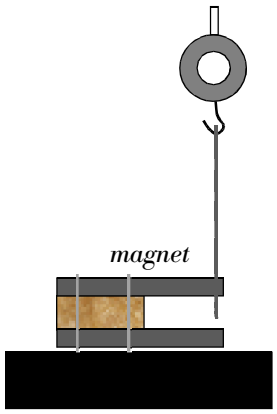
iii. In *Ørsted's Discovery,* the current-carrying wire was being held in place and the magnet was easy to move: (it was small, light, and balanced on a pivot-point). In the following procedure, we will turn the tables by making the magnet hard to move and making the current-carrying wire easy to move.

b. Set Up. Arrange the apparatus as shown below.

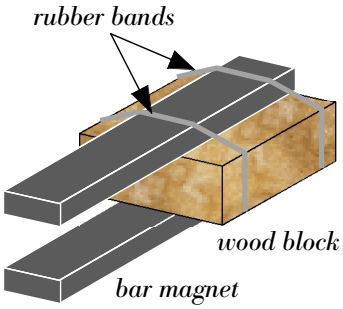
i. The solder is bent into a swing that is **loosely** suspended on the collar hooks. **The solder must swing freely.**

ii. The swing passes between the poles (ends) of the magnets and does not touch either of them.





NOTE: The swing hangs between the *ends* of the magnets (the poles), **not** deeper inside the structure (closer to the wood block).



MAGNET: Sandwich a small wood block between two bar magnets. Secure the arrangement with rubber bands as shown. Note that the magnets are antiparallel: opposite poles face each other.

c. Connect the Genecon wires to the loose ends of the connecting wires on the swing arrangement. Crank the generator and observe the results. Record your observations.

i. Does it matter which way the handle is cranked? Explain.

ii. Does the magnet sandwich need to be in place for the effect to occur? Explain.

iii. Does the orientation of the magnet sandwich make a difference? (Is the effect any different if the sandwich is placed upside down?) Explain.

3. MEET ME IN ST. LOUIS, LOUIE

When some engineering was applied to the principle of magnetic force on a current-carrying wire, the electric motor was invented. This was perhaps the most important technological development made in the 19th century. In this activity, you will investigate the workings of a simple electric motor.

___St. Louis Motor Kit
- __base plate with magnet brackets and armature structure
- __bar magnets (field magnets)
- __field coil
- __6V battery

___connecting wires

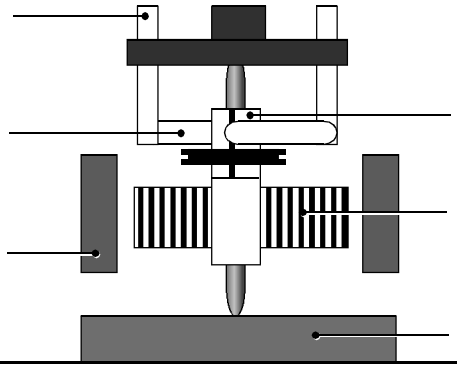
a. Examine the motor; label the following parts on the front view diagram below. **The field coil must not be attached to the motor at this time.** Leave it aside until you are asked to attach it.

- base plate
- field magnet (bar magnet)*
- binding post
- brush**
- split-ring commutator†
- wire-wound armature

** field magnets are bar magnets positioned to establish a magnetic field across the armature—they are to be arranged **antiparallel** to each other; they are held by **securely** attached brackets on the base plate*

*** a metal tab that slides along the spinning commutator*

*† a metal hoop or cylinder with two gaps: **a split ring***



b. Connect the battery to the motor and make it work. (It helps to orient the armature to a position of unstable equilibrium before connecting the wires.) If you can't get it to work, make sure

i. the brushes are brushing. If the brushes are not in contact with the commutator, you do not have a motor.

ii. the field magnets are antiparallel; opposite poles face each other on opposite sides of the armature.

iii. If your motor still does not work, ask the instructor for assistance.

c. While the motor is turning, remove one of the field magnets. (Pinch the magnet bracket ends and slide the magnet out.) Experiment with holding that magnet in various positions/orientations near the armature and record your observations. **Don't run the motor too long; doing so creates a short circuit and drains the battery quickly.**

d. What happens if you remove both field magnets?

e. Disconnect the battery. Remove the field magnets. Attach the field coil. (It has pegs that fit into holes on the St. Louis Motor base plate.) Connect wires from the binding posts on the motor to the binding posts on the field coil so that the motor and coil are connected in parallel. (This is called a *shunt* in electronics.) Reconnect the battery and observe the working motor. How can the motor work without magnets? (Isn't this a contradiction of your finding in the previous part of this investigation?)

f. When it is working, the armature of the motor has mechanical (kinetic) energy. It has been found that energy cannot be created or destroyed, so what is the source of the motor's mechanical energy?

g. Check the correct words to complete the phrase: A motor is a device that transforms __electrical __mechanical energy into __mechanical __electrical energy.

4. BATTERIES INCLUDED

You are now done with MEET ME IN ST. LOUIS and the apparatus associated with that activity.

___Genecon
___2 C- or D-cells
___connecting wires
___4 battery connectors

a. Prediction. What—if anything—would happen if the Genecon were attached to a ***battery*** instead of a light bulb (or resistor of any kind)?

b. Observation. Connect the Genecon to a single 1.5-V battery.
i. What happens? Make an argument for calling the Genecon a **motor** (instead of a generator) under these conditions.

ii. What difference—if any—is there if two batteries in series are connected to the Genecon?

iii. What difference—if any—is there if two batteries in parallel are connected to the Genecon?

c. Connect two batteries in series with the Genecon. What happens if you switch the polarity (switch the + lead to – and the – to +)?

• Post-lab •

Which of the following everyday devices uses a motor?

___alarm clock	___toilet	___shower	___blow dryer	___shaver
___cassette player	___CD/DVD player	___radio	___vending machine	___lights
___computer	___TV	___VCR	___washing machine	___car

Others that **use** motors: