PhyzLab: Magnetic Electricity

using magnetism to create electricity

PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Introduction and Purpose •

When Hans Christian Ørsted found that electricity could create magnetism, all scientists were convinced that magnetism could create electricity. The symmetry was compelling. Still, 11 years would pass before the induction of electricity from magnetic fields would be discovered and understood. The best minds of the day set out to make this widely anticipated discovery, but it was Michael Faraday who put all the pieces together. We will put the pieces together in a different way (in much less than 11 years time). And we will see how Faraday's discovery has been engineered into the device we depend on for electric power in our daily lives.

• Apparatus •

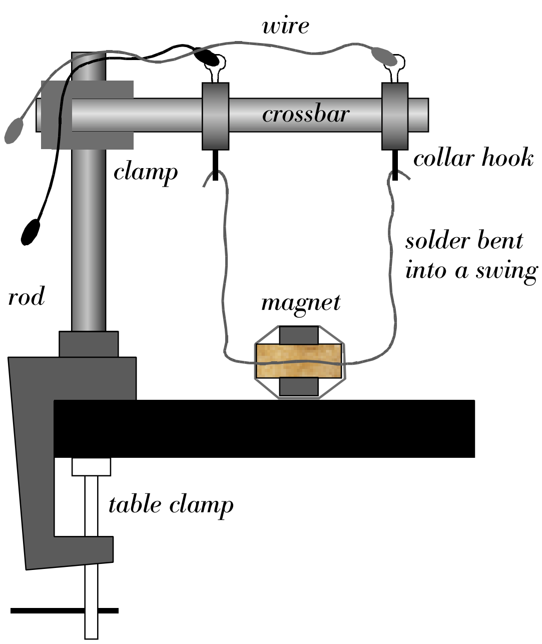
___ a. 2 bar magnets •
___ b. small wood block •
___ c. 2 rubber bands •
___ d. connecting wires
___ e. table clamp and support rod
___ f. right angle clamp and crossbar •
___ g. 2 collar hooks •
___ h. ~50cm of solder (flexible wire) •
___ i. Genecon hand generator
___ j. wire coil (air core)
___ k. access to a second Genecon
___ l. access to a digital multimeter
___ m. St. Louis Motor Kit: St. Louis Motor, 6V battery, field coil, and galvanometer

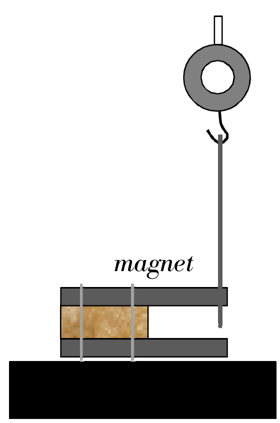
• Procedure •

1. MAGNETIC SWING REVISITED (Apparatus: a, b, c, d, e, f, g, h, l, m)
NOTE: THIS MAY BE DONE AS A DEMONSTRATION

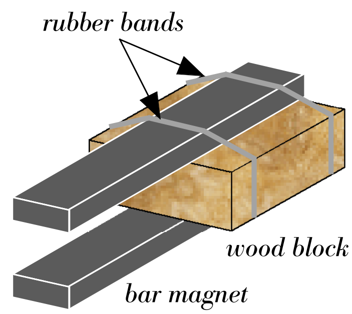
a. Recollection. In a previous experiment, you found that a current-carrying wire experiences a force in a magnetic field. A subtle point here: it was the moving charges in the wire—not the wire itself—that experienced the force.

b. Set Up. Arrange the magnetic swing as you did previously and 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. Add a digital multimeter. Configure the digital multimeter to measure current in the smallest units (or range) available. (A 200 μA range would be appropriate, for example.) Attach a connecting wire to each probe wire of the digital multimeter. Connect those wires to the wires leading to the collar hooks on the magnetic swing.

d. Observation. Quickly move the magnetic sandwich toward and away from the magnetic swing. Don't let the swing itself move too much. Can you see any consequence of this motion on the multimeter? If so, describe it.

e. Gently force the swing back and forth (in and out of the magnetic sandwich). Can you see any consequence of this motion on the multimeter? If so, describe it.

f. Analysis. What does it mean?
When the magnetic field around a wire changes... (complete the statement by writing the consequence.)

2. SQUARE PEG, ROUND HOLE (a, d, j, m)

Note: You are done with the MAGNETIC SWING REVISITED and may disassemble it.

a. Set Up. Use connecting wires to attach the galvanometer to the air core wire coil.

b. Observation. Quickly move one end of a bar magnet in and out of the wire coil. Can you see any consequence of this motion on the galvanometer? If so, describe it.

c. Is this finding consistent with your finding in 1.f.?

3. RETURN TO ST. LOUIS (a, d, m)

a. Set Up.

i. The motor should be configured with bar magnets in place (no field coil).

ii. Connect the galvanometer to the binding posts on the motor.

b. Observation. Push the armature by hand to spin it quickly. Watch the galvanometer as the armature spins.

i. Record your **detailed** observations from the beginning of the motion to when it stops.

ii. Spin the armature the other way and record your observations.

iii. Try this without the field magnets in place. Record your observations.

iv. Try it with the field coil in place (without the field magnets). Record your observations.

v. A device that transforms chemical energy into electric energy is called a **battery**. A device that transforms electric energy to mechanical energy is called a **motor**. What is the name of a device that transforms mechanical energy into electric energy?

4. BACK-TO-BACK (Apparatus: i, k)

a. i. Prediction. What would happen if two Genecons were attached to each other and one of them were cranked? **Don't do it yet,** *predict* what would happen and explain why it would happen.

ii. Observations. Obtain a second Genecon, connect the two and record your observations.

b. Does switching the polarity (reversing the connections) make any difference? Describe.

c. Make careful, *quantitative* observations of what happens when two Genecons are connected and one is cranked.

d. **Efficiency** is the ratio of work output of a machine to the work input. For example, if you have to put 100 J of work into a machine for it to do 25 J of work, the machine has an efficiency of 25 J / 100 J = 0.25. We might say it has an efficiency of 25%. What is the efficiency of the Genecon-Genecon arrangement? Show your calculation.

e. The efficiency of the arrangement is less than 100%. Where does the "lost" energy go?