TEXAS A&M UNIVERSITY

PHYSICS LECTURE DEMONSTRATIONS

Colleagues,

The Physics Demonstration Program has been reorganized and updated for implementation in the new George P. and Cynthia Woods Mitchell Institute for Fundamental Physics and Astronomy and the George P. Mitchell '40 Physics Building. Click here to view Electricity and Magnetism Demonstrations.

The labeling system of the demonstrations has also been changed. The new labeling will incorporate the Demonstration Classification System (DCS) suggested by PIRA, the Physics Instructional Resource Association. The goal of the PIRA Demonstration Classification Scheme is to create a logically organized and universally inclusive taxonomy giving a unique number to every lecture demonstration.

External website references have been added to the demonstration notes when possible. These references have information (historical and practical) to supplement the notes listed in the demo page.

If you are interested in using one of these demonstrations in your classroom, you may send me an email with your class information and the demonstration number and name. Please allow at least two class days notice for the demonstration requests.

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Electricity and Magnetism

[Electrostatics]

5A10.10 PRODUCING ELECTROSTATIC CHARGES
5A40.20 USING A CHARGE ON A ROD TO MOVE A COKE CAN
5A40.30 ELECTROSTATIC FORCE IN MOVING A WOOD BOARD
5A50.30 VAN DE GRAAFF GENERATOR

[Electric Fields and Potential]

5B20.10 FARADAY "ICE PAIL"

[Capacitance]

5C10.10 ASSORTMENT OF CAPACITORS
5C10.20 PARALLEL PLATE CAPACITOR

[Resistance]

5F20.50 SERIES AND PARALLEL LIGHT BULBS (CIRCUIT ANALYSIS)

[DC Circuits]

5F30.20 RC TIME CONSTANT

[Magnetic Fields and Forces]

5H10.20 OERSTED'S EXPERIMENT (WIRE OVER A COMPASS)
5H10.30 MAGNETS AND IRON FILINGS (MAGNETIC FIELDS)
5H15.10 MAGNETIC FIELD AROUND A WIRE AND SOLENOIDS
5H15.40 MAGNETIC FIELD AROUND A LARGE COIL
5H40.30 MAGNETIC FORCE ON A CURRENT CARRYING WIRE
5H40.35 MAGNETIC FORCE ON CURRENT CARRYING COIL

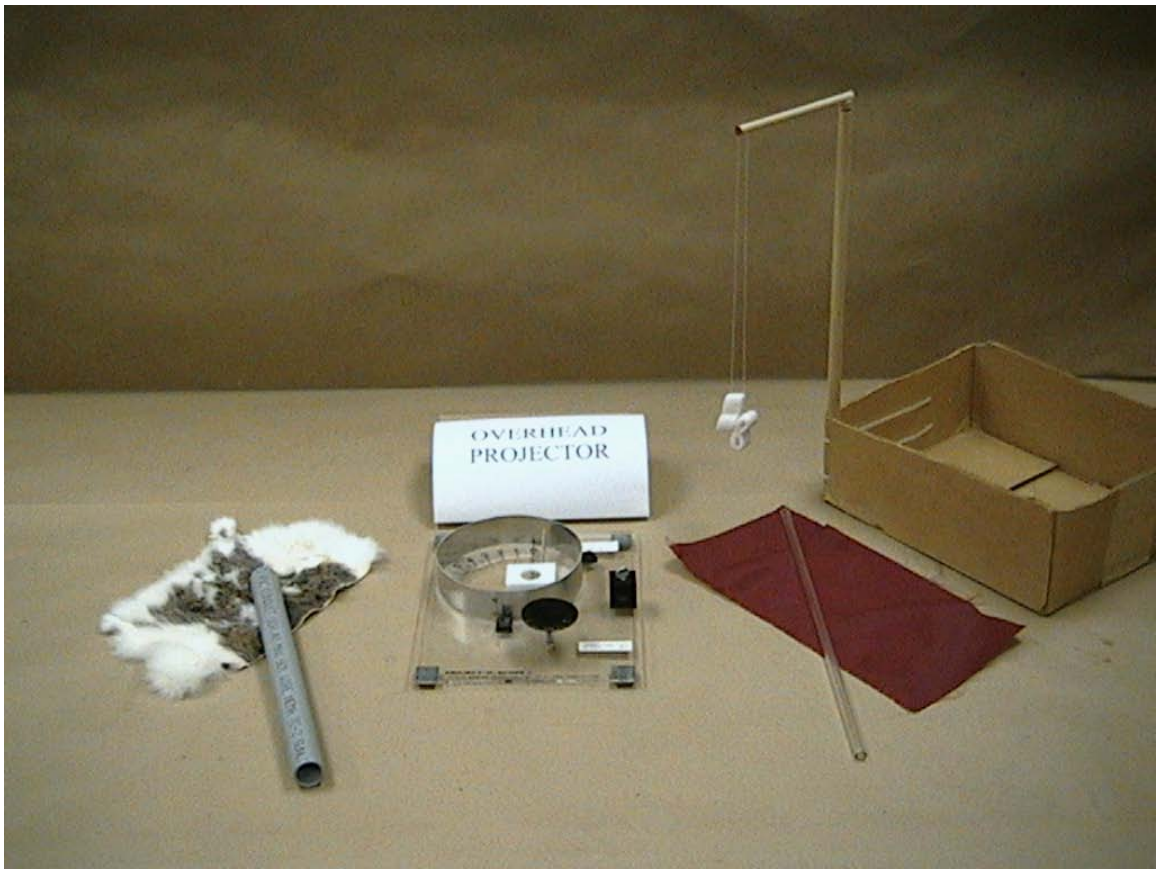
[Electromagnetic Induction]

5K10.20 INDUCED EMF IN A COIL
5K20.10 EDDY CURRENT PENDULUM
5K20.25 MAGNET FALLING IN TUBE (LENZ'S LAW)
5K20.26 MAGNETIC FORCE ON METAL RINGS (LENZ'S LAW)
5K20.30 JUMPING RINGS
5K30.10 JACOB'S LADDER
5K40.10 DC MOTOR APPARATUS
5K40.40 AC GENERATOR
5K40.80 HAND CRANK GENERATOR

[AC Circuits]

5L10.10 AC VS DC VOLTAGE ON AN INDUCTIVE COIL

5A10.10 PRODUCING ELECTROSTATIC CHARGES



Apparatus: Electroscope
PVC tube and animal fur
Glass tube and paper towel
Pith balls on stand

Notes: Place the electroscope on the overhead projector or Elmo surface. Rub the PVC tube with the animal fur and then "slide" the edge of the tube across the black metal disc of the electroscope, thus putting a negative charge on the disc. Charge the glass rod by rubbing it with the paper towel and bring the rod (now with a positive charge) close to the disc of the electroscope. Note that the indicating needle of the electroscope will indicate a reduced charge on it. The pith balls may also be used to show the charge on the rod or tube.

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5A40.20 USING A CHARGE ON A ROD TO MOVE A COKE CAN

Apparatus: PVC tube and animal fur
Metal can

Notes: Rub the PVC tube with the animal fur and move the tube next to the metal can (as shown in the picture). The charge on the tube will cause the metal can to be repelled.

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5A40.30 ELECTROSTATIC FORCE IN MOVING A WOOD BOARD

Apparatus: Long wooden board
Watch glass (or large lens)
PVC tube and animal fur

Notes: Balance the wood board on the watch glass. Rub the PVC tube with the animal fur to put a charge on it. Bring the long side of the tube near the end of the wood board. The charged tube will attract the wood board.

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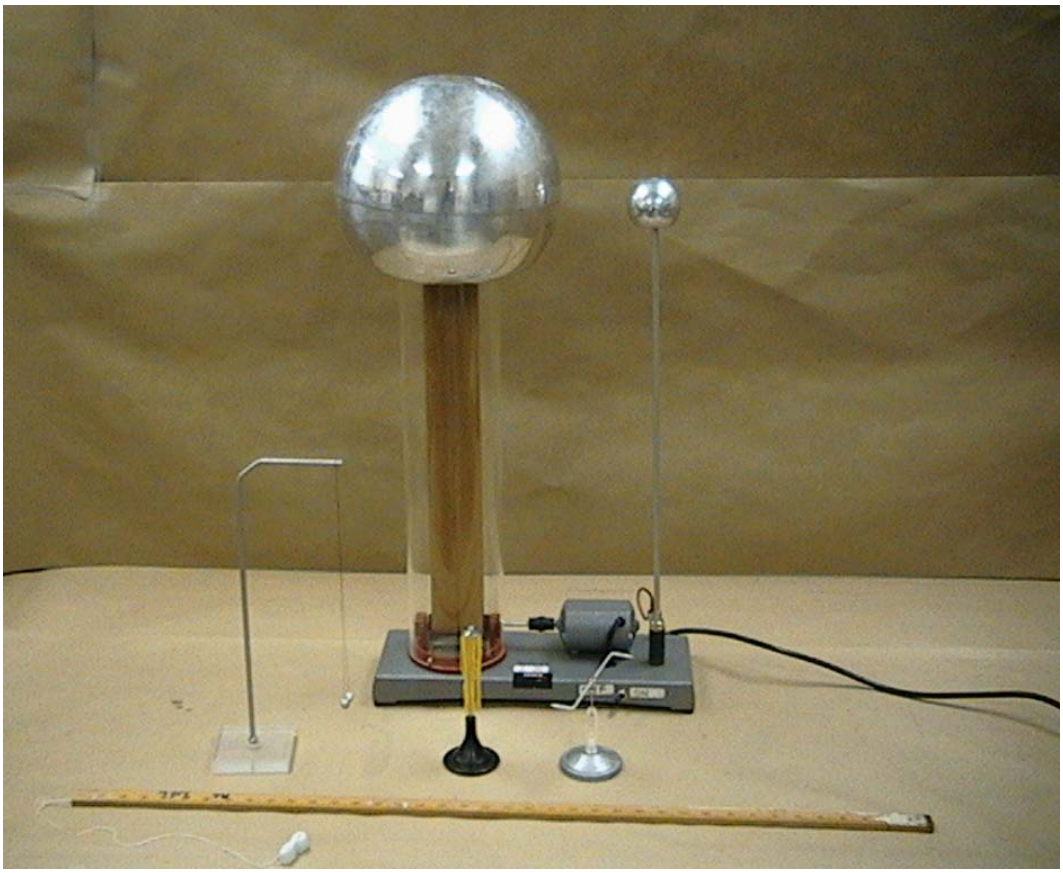
5A50.30 VAN DE GRAAFF GENERATOR



Apparatus: Van de Graaff generator (VDG)
Meter stick with pith balls on it
Pith balls on stand
Whirl on a stand
Threads on a stand
Extra meter stick (to turn off the VDG and not get shocked)
Masking tape or scotch tape

Notes: CAUTION – The generator can produce high voltages (up to 500 Kv). The sphere (mounted on the same base as the VDG) may be used to ground the charge on the VDG when it is turned off. This will make the VDG safer to touch.
To show the charge on the VDG, tape the whirl or the threads apparatus to the top of the VDG. The pith balls may also be brought close to the top of the VDG.

References: http://en.wikipedia.org/wiki/Van_de_Graaff_generator

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5B20.10 FARADAY "ICE PAIL"

Apparatus: Electroscope (Project-o-scope)
PVC tube and animal fur
Conducting cup on stand
Proof plane

Notes: Rub the PVC tube with the animal fur and touch (or rub) the tube to the inside edge of the metal cup. Take the proof plane, touch the inside of the metal cup with the plane and then touch the top black disk of the electroscope. Do this a few times to verify that there is no charge inside the cup that is transferred to the electroscope. Now, with the proof plane, touch the outside of the cup and then touch the top disk of the electroscope. Do this a few times. What happens to the needle of the electroscope? Does it show a charge present on the outside of the cup?

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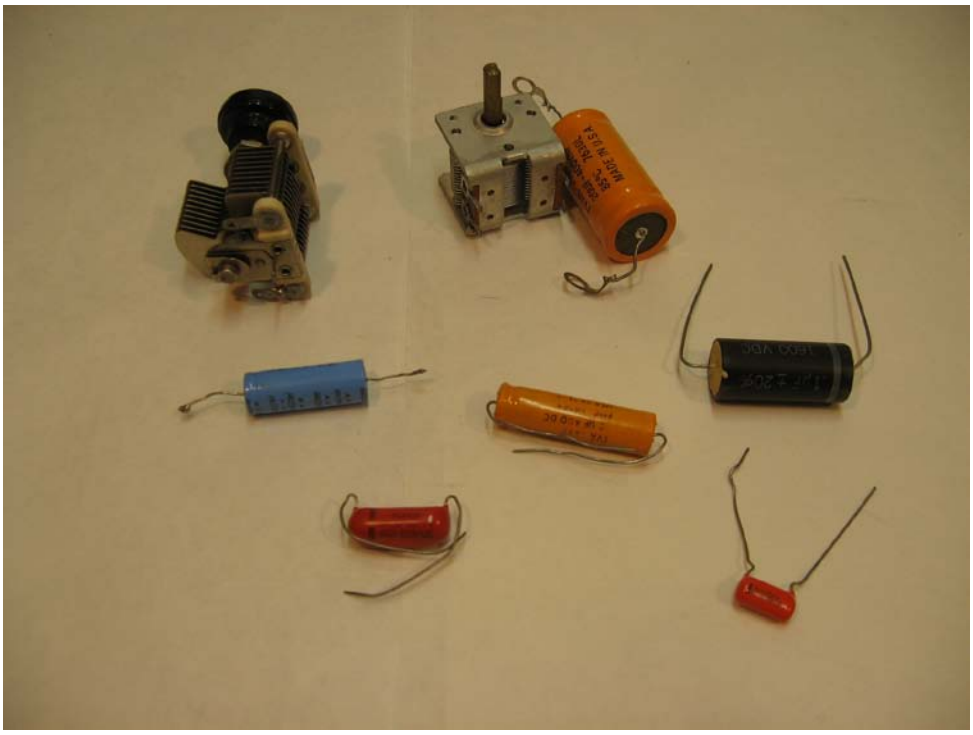
5C10.10 ASSORTMENT OF CAPACITORS



Apparatus: Assortment of capacitors (mica, air, variable, electrolytic)

Notes: Show the students in the class the different types of capacitors.

References: http://en.wikipedia.org/wiki/Capacitor

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5C10.20 PARALLEL PLATE CAPACITOR

Apparatus: Electroscope (project-o-scope)
Large parallel plate capacitor
Overhead projector or Elmo projector
High Voltage generator and AC adapter
Co-axial leads

Notes: Place the electroscope on the overhead projector (or Elmo projector) and attach the capacitor to the electroscope. (Note the specific locations on the photo.) Charge the capacitor with the HV generator (about 3000 volts) by touching the leads to the sides of the plates. Move the plates of the capacitor closer together and apart and observe the reading on the electroscope.

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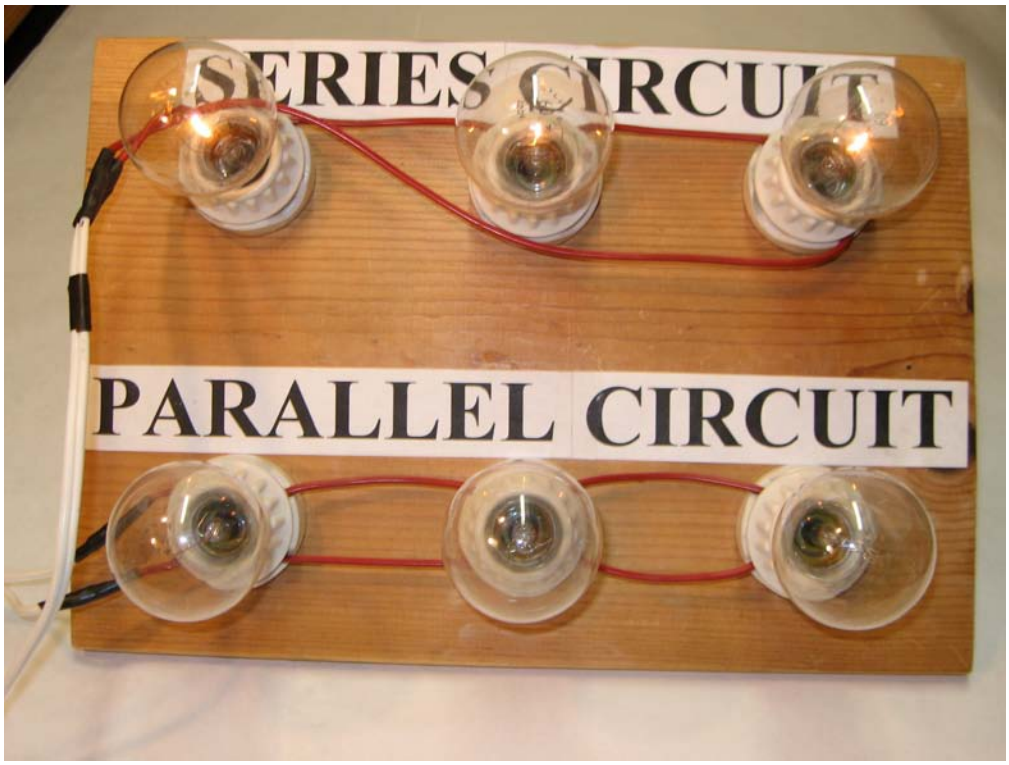
5F20.50 SERIES AND PARALLEL LIGHT BULBS (CIRCUIT ANALYSIS)



Apparatus: Circuit board with light bulbs in series and parallel

Notes: Plug in the power cord to the AC power outlet. Demonstrate the difference in light output of the series and parallel circuits. Show what happens in the two circuits when a bulb is unscrewed from the socket.

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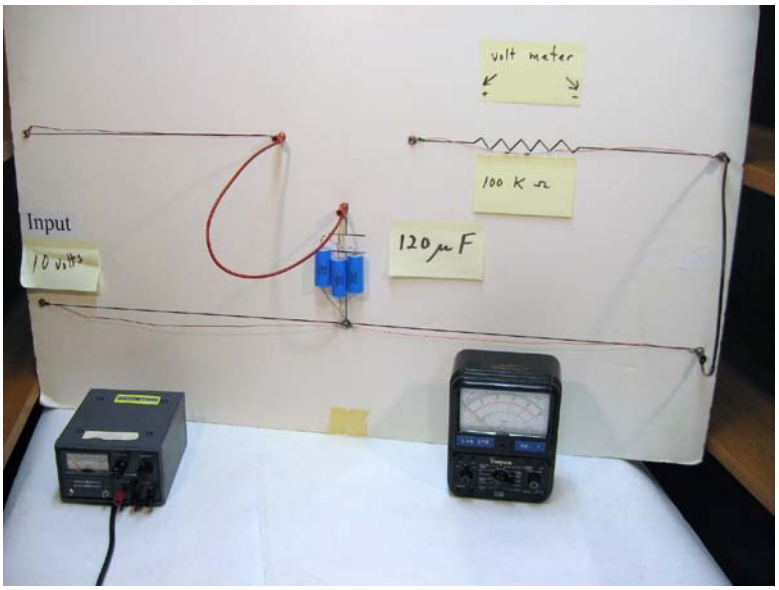
5F30.20 RC TIME CONSTANT



Apparatus: Elmo projector (to project the meter image)
RC decay apparatus board
12 volt HP power supply
Simpson meter
Long leads
Tall stand for support of the apparatus board

Notes: Place the RC apparatus board on the table and connect the power supply to the input jacks (about 10 volts). Connect the meter across the 100 K resistor.

Charge the capacitor by (connecting) touching the wire between the capacitor and the power jack. Now move the wire to the nearest side of the 100 K resistor. This discharges the capacitor across this resistor. The voltage decay across the resistor is shown on the meter.

(set up info – be sure to use extra long leads for the power supply and voltmeter.)

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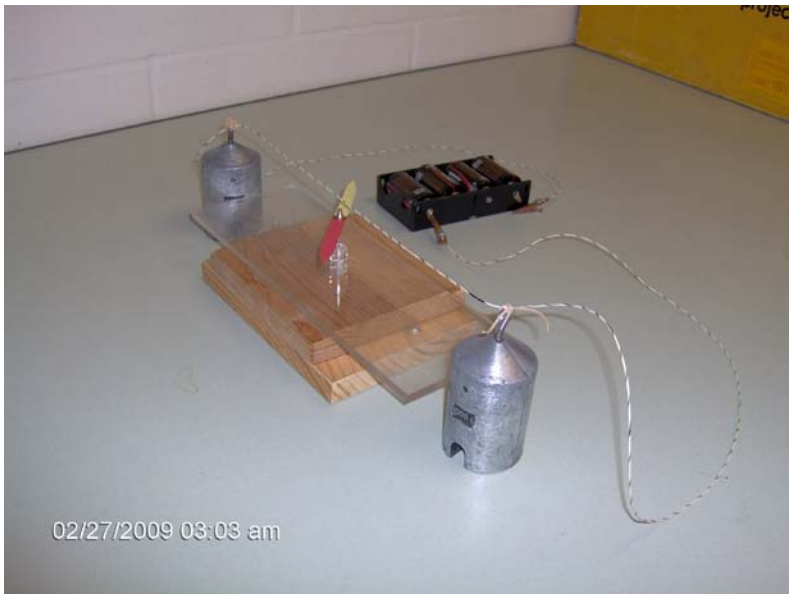
5H10.20 OERSTED'S EXPERIMENT (WIRE OVER A COMPASS)



Apparatus: Compass needle on plastic base
Wood blocks to support the compass base
Heavy metal stands with length of wire attached to them
Battery pack (with two batteries)

Notes: Align the compass such that it is parallel to the N-S field of the earth. Place the metal stands such that the wire is directly above the compass needle (use the wood blocks if needed). Attach the battery pack to the wire. [Remove the battery from the wires when not using the demo.]

References: http://en.wikipedia.org/wiki/Hans_Christian_%C3%98rsted

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5H10.30 MAGNETS AND IRON FILINGS (MAGNETIC FIELDS)

Apparatus: Clear plastic sheet with magnets glued to the inside.
Iron filings container
Elmo projector

Notes: Sprinkle a small amount of filings on top of the magnets.

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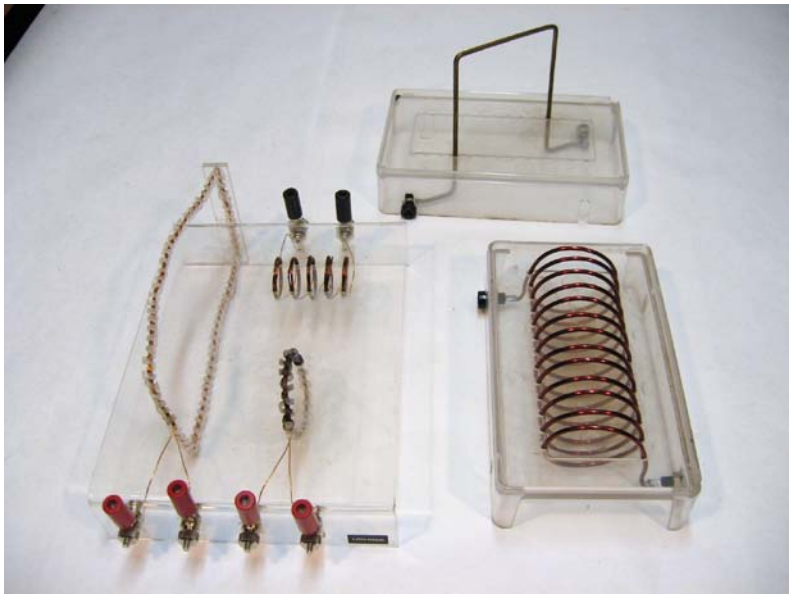
5H15.10 MAGNETIC FIELD AROUND A WIRE AND SOLENOIDS



Apparatus: Overhead projector or Elmo projector
Field sources (assortment)
Iron filings
Large power supply and leads

Notes: Place the field sources on the projector. Connect the power supply to the jacks on the plastic boxes. Sprinkle iron filings on top of the sources to display the magnetic fields. Do not exceed 6 amps thru the wires.

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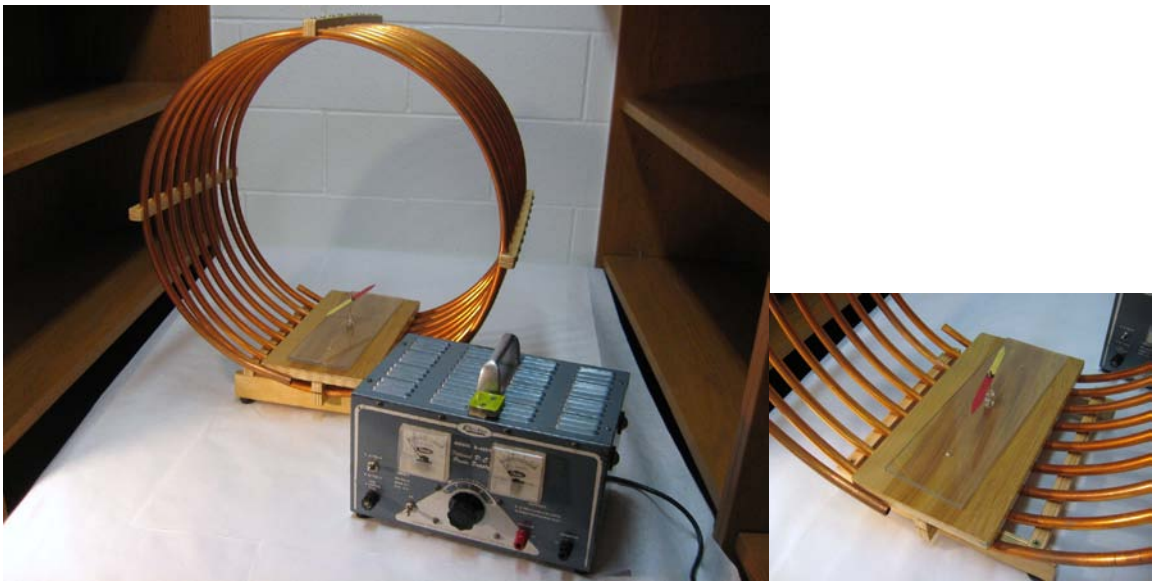
5H15.40 MAGNETIC FIELD AROUND A LARGE COIL



Apparatus: Large coil on wood stand
Compass needle on stand
Large power supply and long leads with clips

Notes: Attach the power supply to the ends of the large coil. Use the compass to illustrate the magnetic field around and inside the coil.

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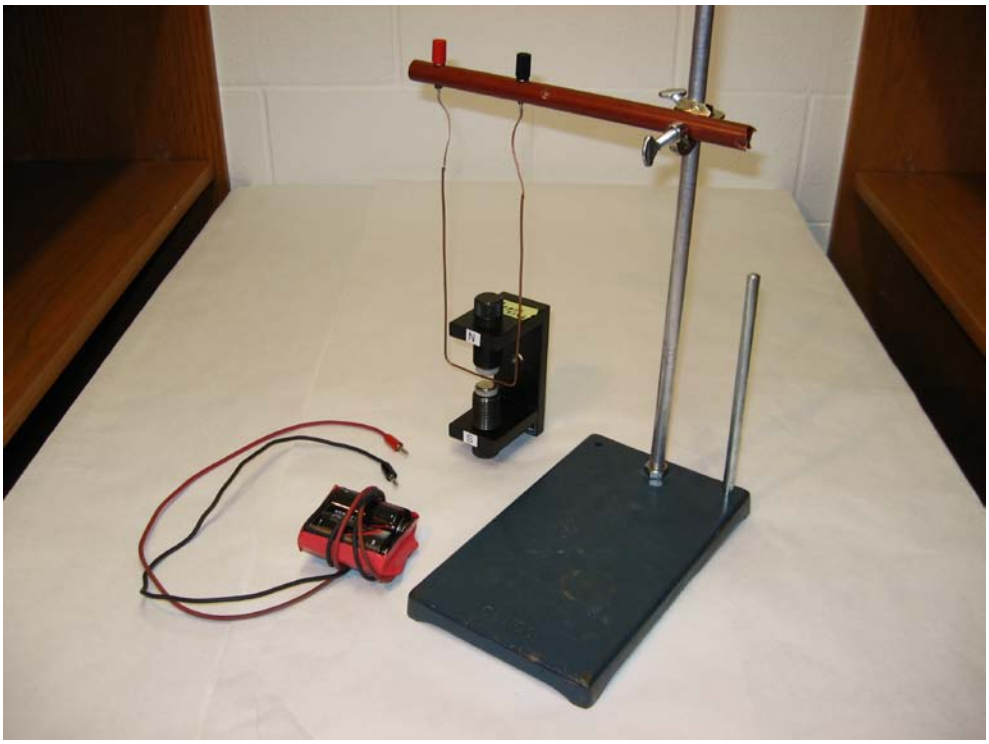
5H40.30 MAGNETIC FORCE ON A CURRENT CARRYING WIRE



Apparatus: Deflected bar apparatus
Pasco magnet on its side with N and S labels
2 batteries on holder and leads

Notes: Connect the battery leads to the jacks on the deflected bar apparatus.

(Set up info – be careful with the brown tube, it is thin and fragile.)

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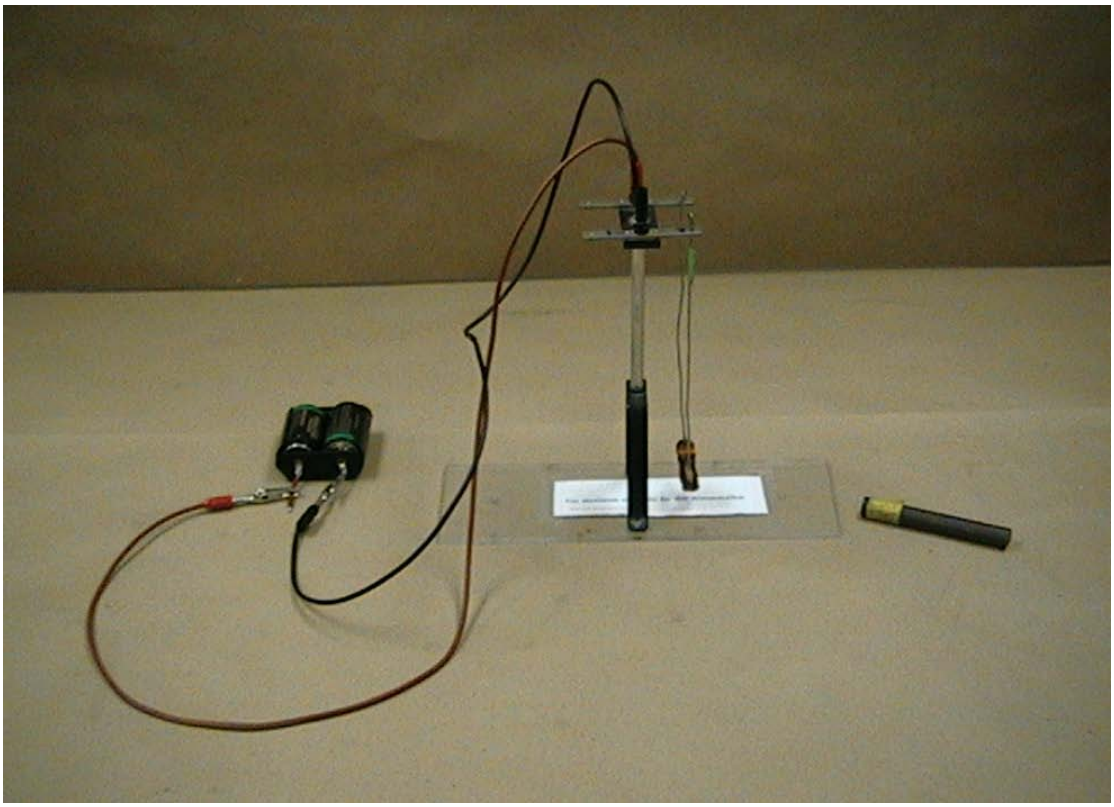
5H40.35 MAGNETIC FORCE ON CURRENT CARRYING COIL



Apparatus: Coil on mount
Bar magnet
Two batteries on holder and leads

Notes: Connect the batteries to the coil. Use the bar magnet to cause the coil to swing back and forward. Show the force on the coil due to the magnetic field of the magnet.

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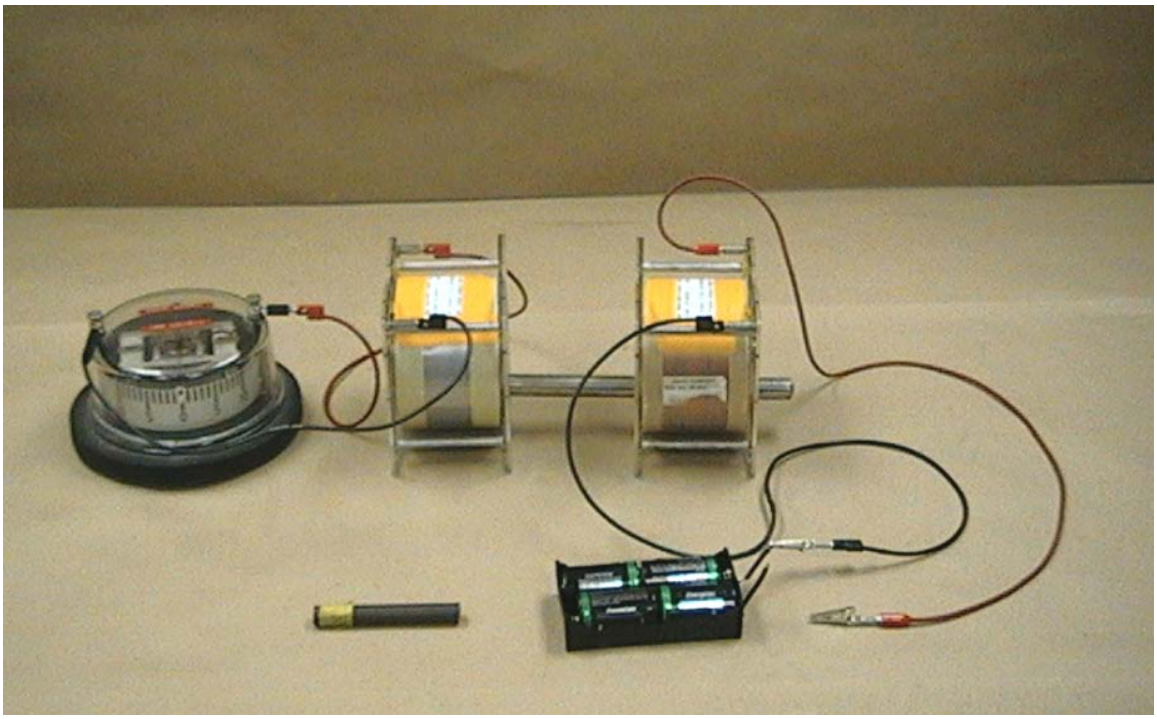
5K10.20 INDUCED EMF IN A COIL



Apparatus: Galvanometer 2 Large coils
Bar magnet Battery pack of 4 batteries and leads
Steel bar (for coupling)

Notes:
Using a current source -
Connect the coil on the left (in the photo) to the galvanometer and coil on the right to the battery pack as shown (but leave one lead disconnected to the battery pack). The steel bar should be inserted inside the two coils. “Touch” but do not connect the loose end of the battery pack lead to the terminal of coil on the right. Note the response of the galvanometer needle. Remove the lead and at the same time, note the response on the galvanometer. What is the response?

Using a magnet -
Separate the first coil from the second coil. Bring one of the pole ends of a magnet close to the opening of coil connected to the galvanometer. Quickly insert the magnet into the coil. What is the response on the galv? Quickly remove the magnet. What happens now? Try the other end of the magnet. Try the other opening of the coil. What were the results? Now “slowly” insert the magnet into the coil.

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5K20.10 EDDY CURRENT PENDULUM

Apparatus: Eddy current apparatus and set of attachments
Pasco magnet (as shown)

Notes: Attach one of the attachments to the support rod and allow it to swing through the opening between the magnet poles (as shown). Note the difference (in damping) between the attachment with slits and the one without slits.

An undergraduate's view on eddy currents:
http://www.physlink.com/Education/AskExperts/ae527.cfm

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5K20.25 MAGNET FALLING IN TUBE (LENZ'S LAW)

Apparatus: Brass rod and plastic tube apparatus
Neodymium magnet

Notes: Hold the tubes in a vertical orientation. Allow the magnet to drop in the plastic tube and show how quickly it goes through the tube. Now, drop the magnet in the brass tube.

References: http://en.wikipedia.org/wiki/Eddy_current

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5K20.26 MAGNETIC FORCE ON METAL RINGS (LENZ'S LAW)

Apparatus: 2 metal rings on a lucite rod attached to a rod and base
Bar magnet

Notes: One ring is split and the other is solid. Oscillate the bar magnet in and out of the rings to try to cause them to swing.

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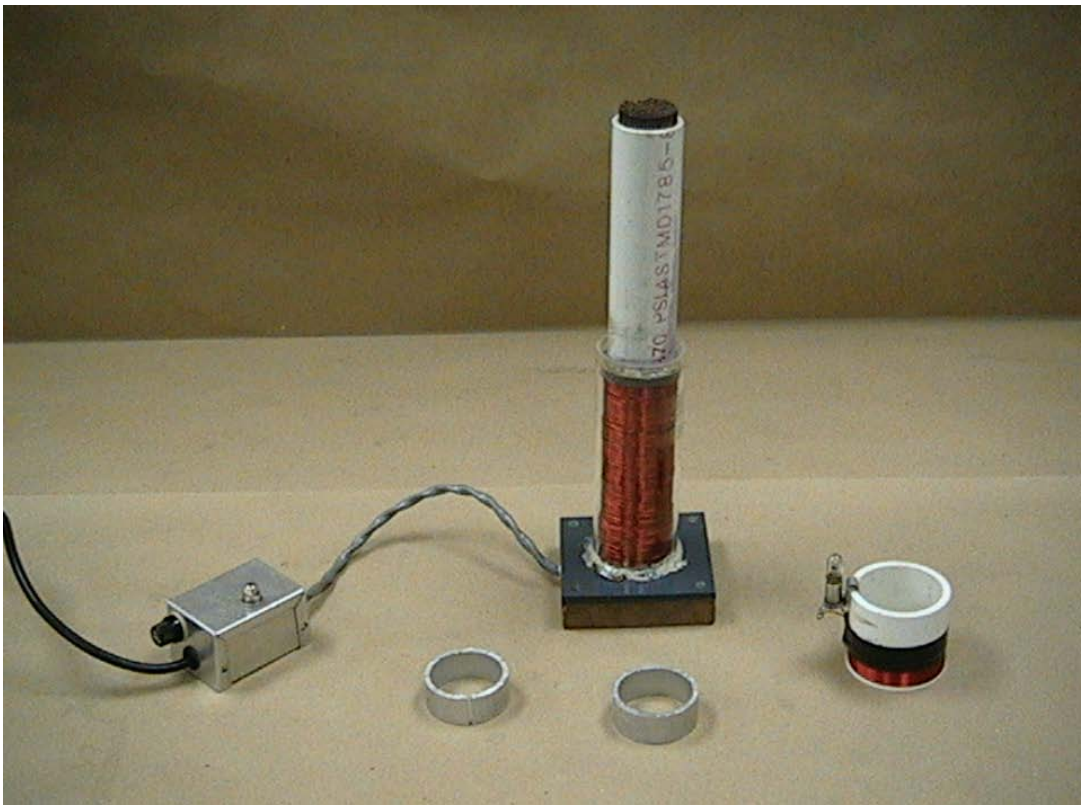
5K20.30 JUMPING RINGS



Apparatus: Small jumping ring apparatus
2 rings – one solid and one with a slit in it
Coil of wire with a light attached to it

Notes: Use the push button on the jumping ring to make the rings jump up in the air or to make the bulb light up.

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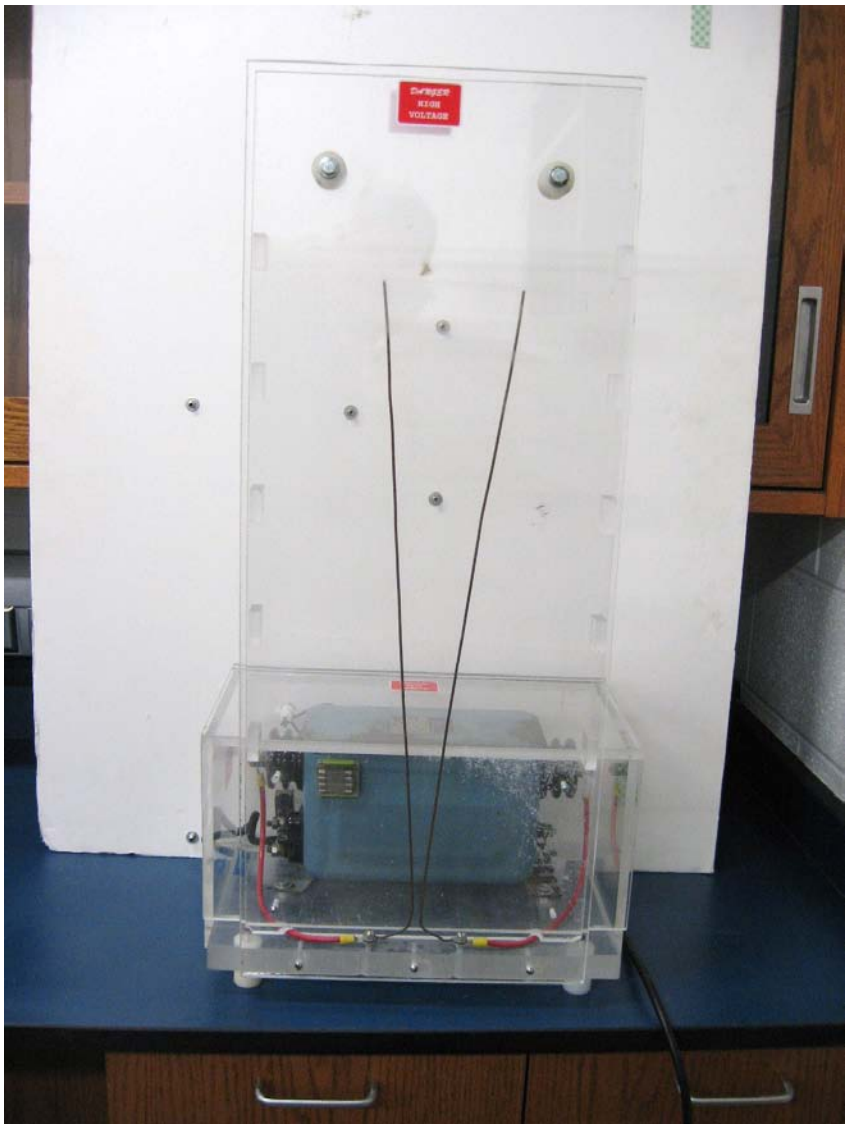
5K30.10 JACOB'S LADDER



Apparatus: Jacob's ladder apparatus

Notes: Use the on/off switch to apply power to the transformer and the vertical wires.

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5K40.10 DC MOTOR APPARATUS

Apparatus: Large motor apparatus
3 amp power supply and leads

Notes: Connect the power supply [red (black) terminals of motor to the red (black) jacks of the power supply]. Slowly increase the output voltage (MAX 3 AMPS) of the power supply until the motor coils rotate. One may have to pre-set the alignment of the coils of the motor in order for it to rotate.

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5K40.40 AC GENERATOR

Apparatus: Large generator apparatus
Galvanometer and leads

Notes: Connect the generator to the galvanometer. Rotate the spindle of the generator to show that it generates a current as shown on the galvanometer.

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5K40.80 HAND CRANK GENERATOR

Apparatus: "Crank generator"

Notes: The crank generator consists of permanent magnets with an armature that rotates as the handle is turned. The turning of the handle on the generator produces current through the neon bulb. The generator should be operated at a slow speed (or the handle will break).

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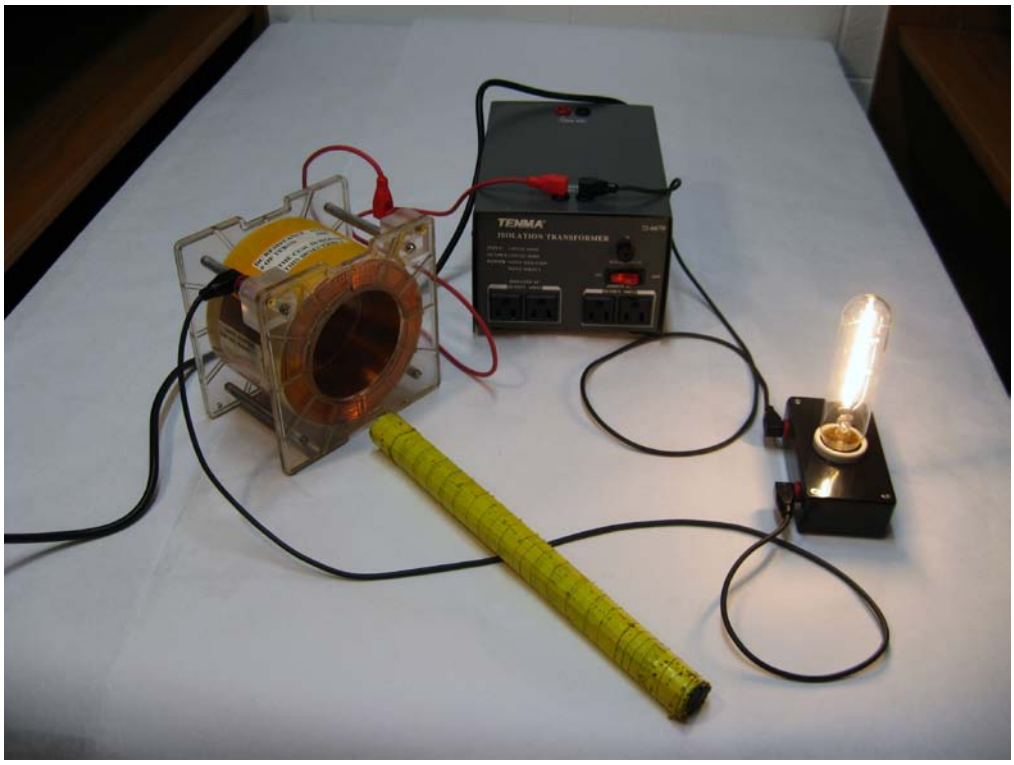
5L10.10 VS DC VOLTAGE ON AN INDUCTIVE COIL



Apparatus: 1 large coil
Light bulb on base
Iron rods wrapped in yellow tape
AC/DC voltage output circuit box and leads

Notes: Connect the circuit box (DC output) in series with the large coil and light bulb. Insert the iron rod bundle into the center of the coil and note that there is no change in the brightness of the bulb. Now reconnect the circuit to the AC output of the circuit box and again insert the iron rods into the coil. What happens now?

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