



Electricity Merit Badge

Class 2 - Magnetism



27 April 2014

Electricity Merit Badge Class 2 - 2010 National Scout Jamboree

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Classes

- Class 1 – Basic Electricity (shared with the Electronics Merit Badge)
- **Class 2 – Magnetism**
 - Magnets & Compasses
 - Electromagnets & Coils
 - Solenoids & Electric motors
- Class 3 - Electric Power, Alternating Current
- Class 4 – Safety at Home



Magnets – Attraction & Repulsion



- What happens when you push 2 N (north) poles close together?
- When you put an N and S pole close?



Four Forces

Magnetic

- The force attracts and repels and holds atoms and molecules together

Gravity

- The force is always attractive and acts along the line joining the centers of mass of the two masses

Weak Force

- The weak interaction acts between both quarks and leptons

Strong Force

- A force which can hold a nucleus together against the enormous forces of repulsion of the protons



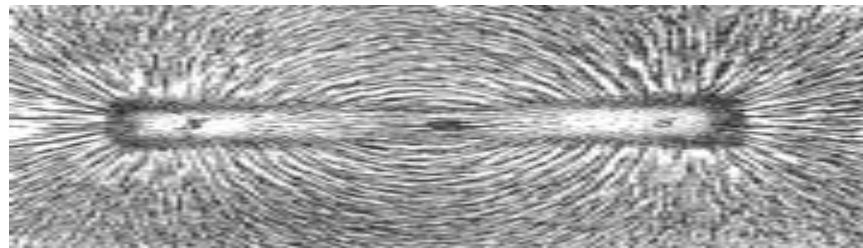
Magnets and Metal

- Some metals are attracted to magnets
- Some metals are not
- Why is that?
- iron and steel (nails, screws and nuts)
- stainless steel (forks and spoons)
- brass (screws)
- copper (coins)
- aluminum (foil)

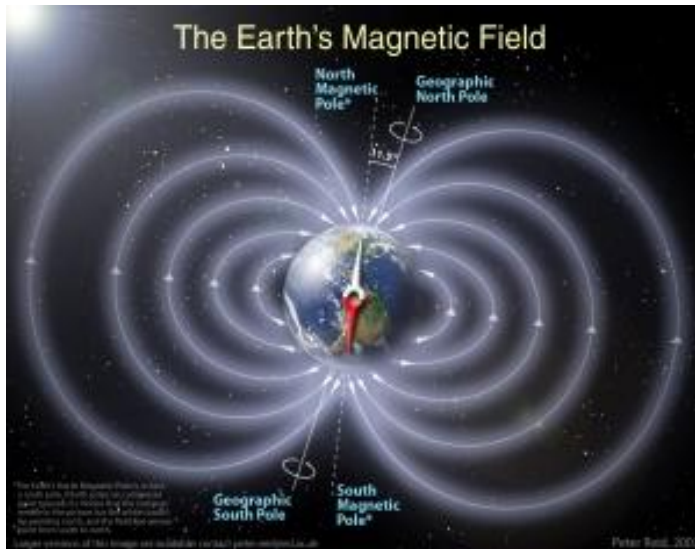


Magnetic Lines of Flux

- Iron is attracted to magnets
- Using tiny bits of iron to see how the lines of magnetism
- Strong at the poles, weak away from poles



Magnetic Lines of Flux



- The earth is a big magnet
- The needle of a compass is magnet
- The S pole of the compass points to the N pole of the earth



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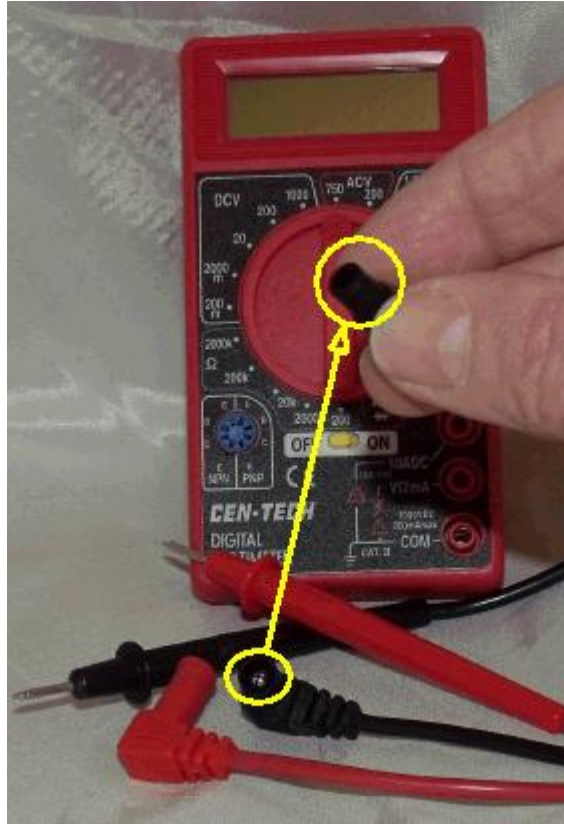
Using a Multimeter 1



- Remove meter from packaging
- Watch out for the staples!
- Included are two test probes



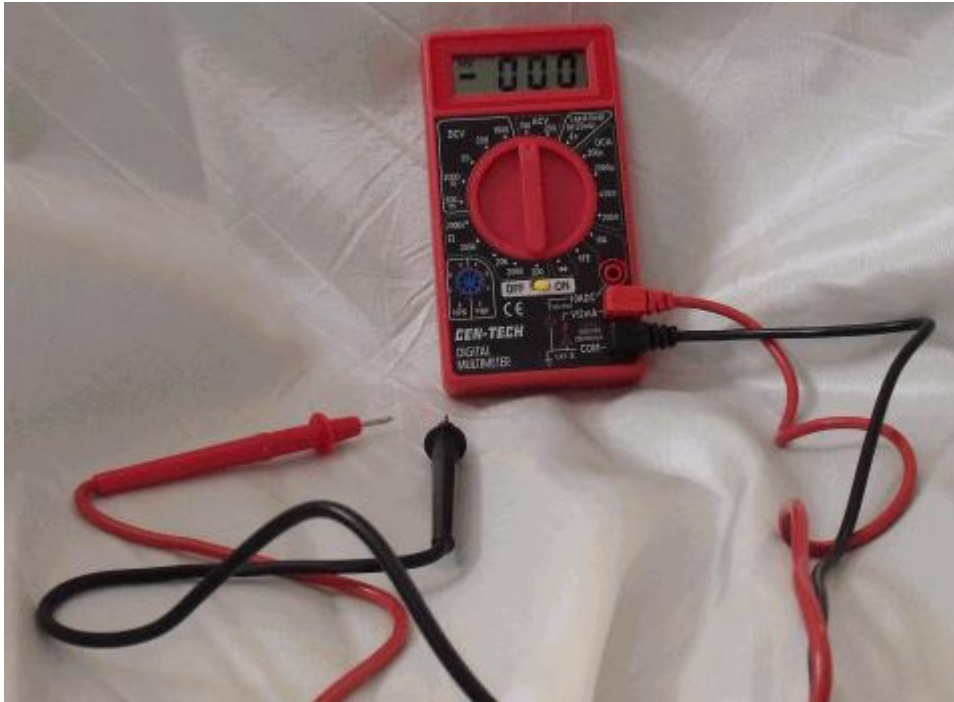
Using a Multimeter 2



- Remove the protecting covers from black and red connectors (plugs)
- Plug the black connector into the COM jack
- Plug the red connector into the V Ω mA jack



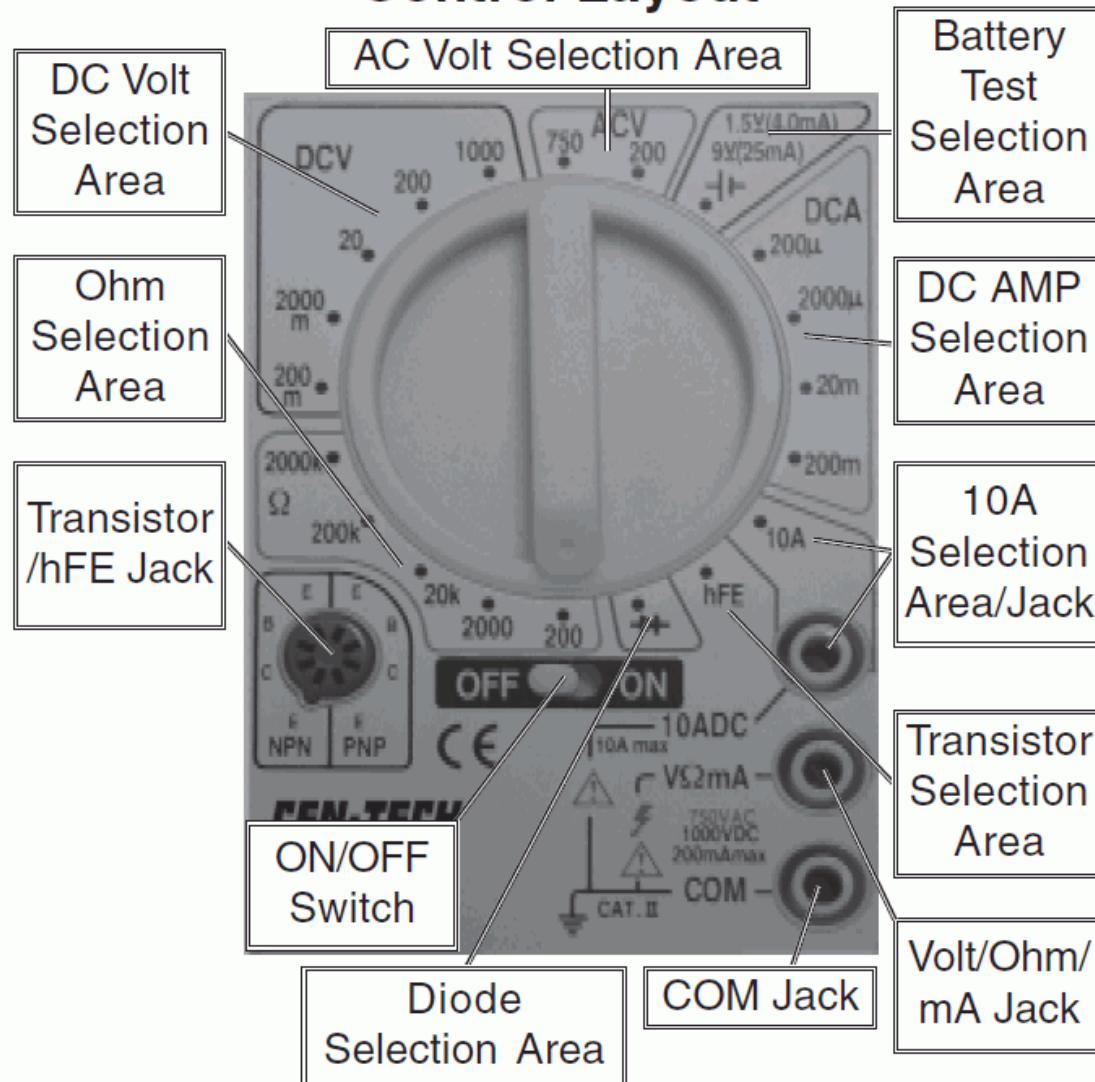
Using a Meter to Measure



- DCV = Battery
- ACV = Wall socket
- Ω = Checking Fuses & Bulbs
- Others = Read the manual



Control Layout

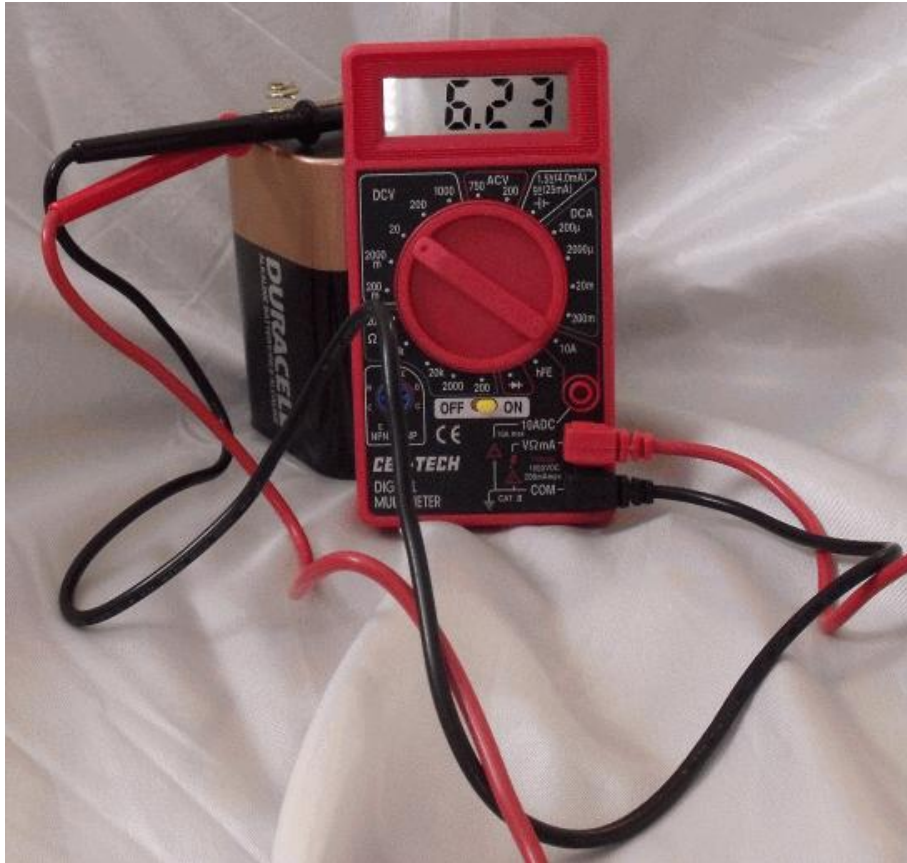


Full manual available at:

<http://www.harborfreight.com/cpi/ctaf/manuals.taf?f=form&ItemID=98025>



Be Careful When Measuring



- Check Maximum rating such as “750VAC”
- Pick the right range
 - ACV?
 - DCV?
 - Ω ?
- Start at the highest and work down in value as needed



Watch Your Fingers



- Don't let your fingers slip past the protective barrier
- Touching the metal probe while it is connected to a circuit can shock you
- Also it may make the meter reading invalid

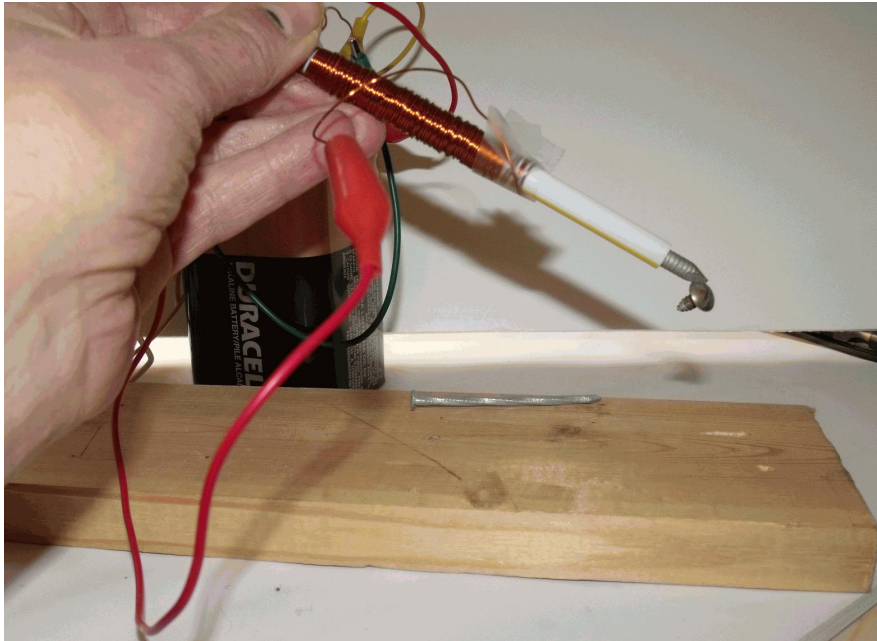


Magnets and Wires - Electricity

- Move a magnet near a coil of wire and you get electricity
- Move a coil of wire near a magnet and you get electricity
- The magnetic force moves electrons in the wire creating a wave of energy



Wires and Electricity - Magnet



- Put wires around some magnetic material
- It becomes a magnet
- “Electromagnet” is the official name

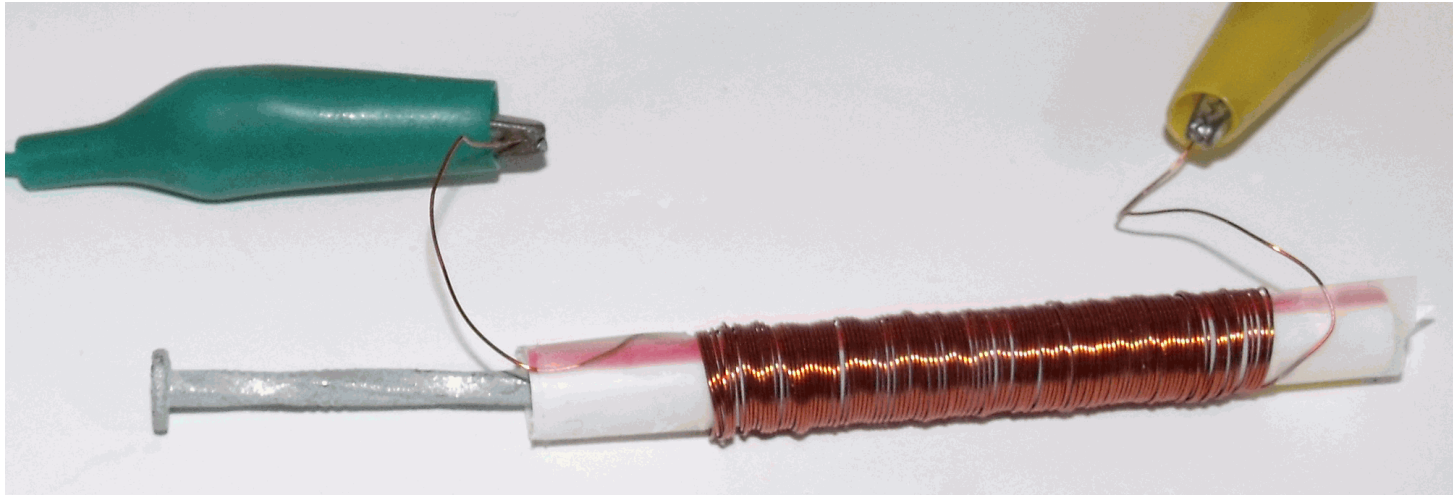


Put On The Safety Glasses

- You will be working with sharp, pointy objects
- We don't want you poking something into your eye.



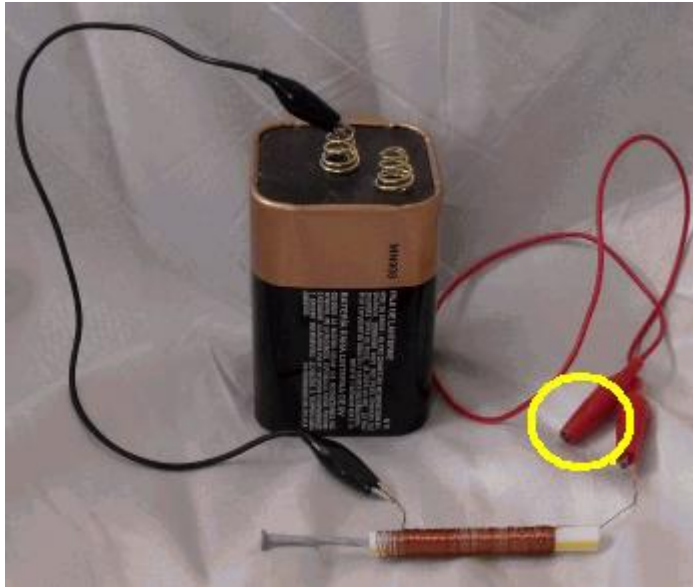
How We Built the Coil for the Electromagnet



- A 10-foot length of #28 “magnet wire” was wrapped about 40 times around the straw
- Used hot glue to hold the wire in place
- Used sandpaper to clean the coating off the two wire ends



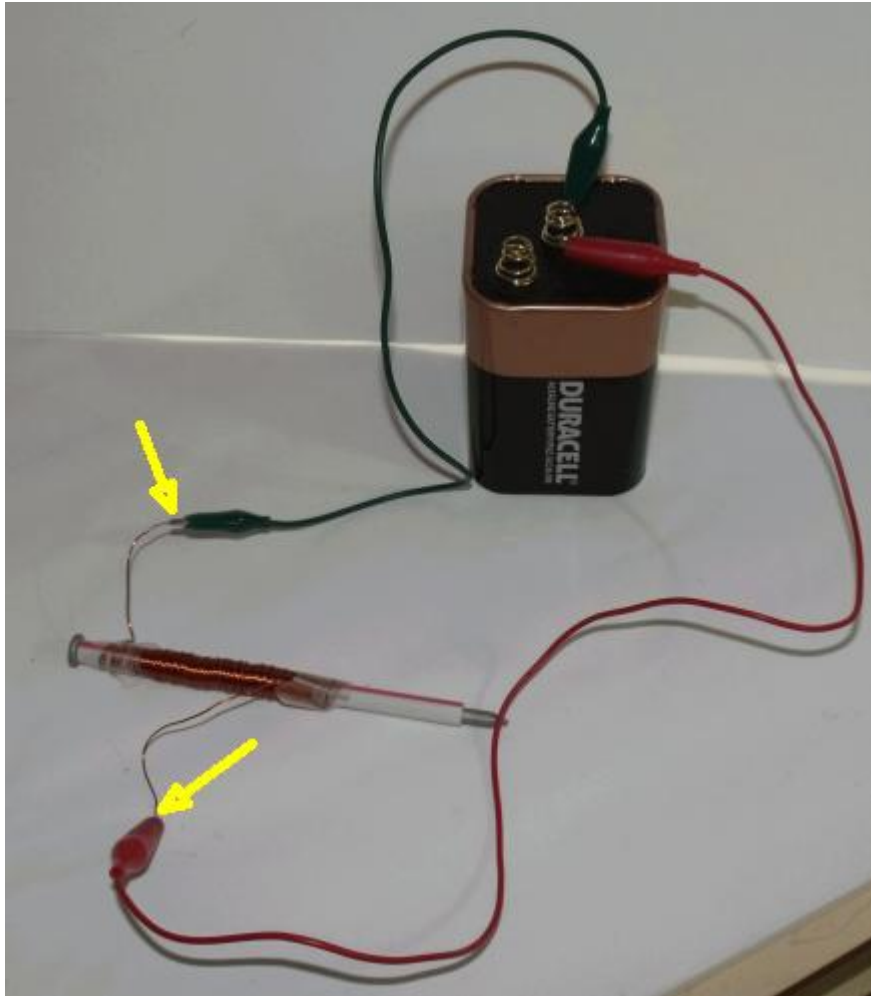
Caution – Coil Gets Hot



- Disconnect the coil as soon as it feels hot
- It could burn you if left connected
- It drains the battery



Building an Electromagnet



- Put the spike inside the straw
- Connect one clip of each alligator clip lead to the ends of the wires on the coils
- Connect the alligator clips to the battery
- Use the end of the spike to pick up metal
- Disconnect battery

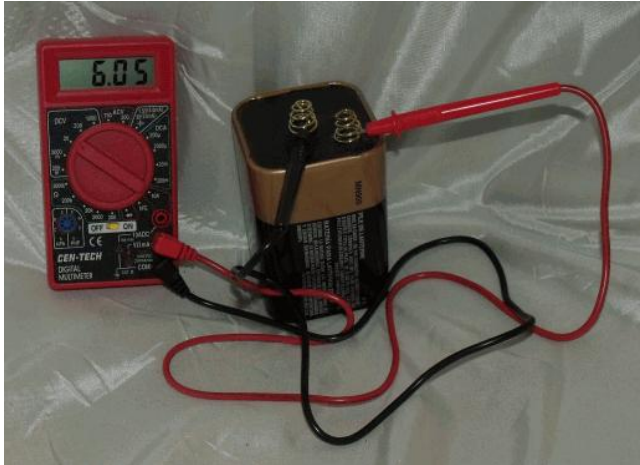


Disconnect the battery quickly because...

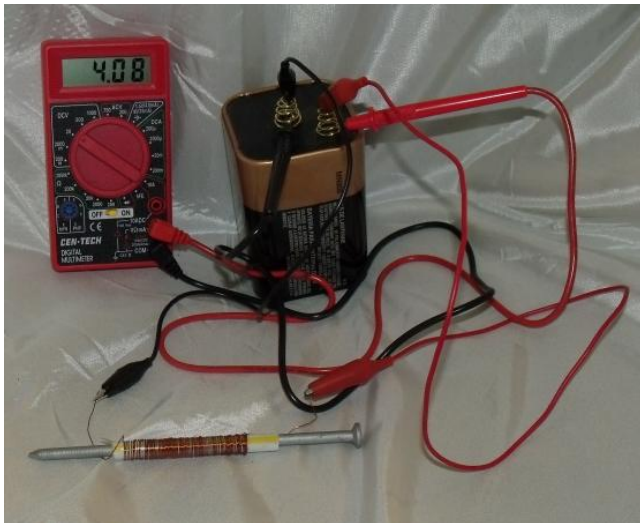
1. It gets the coil really hot
2. It wears out the battery by putting a heavy load on it



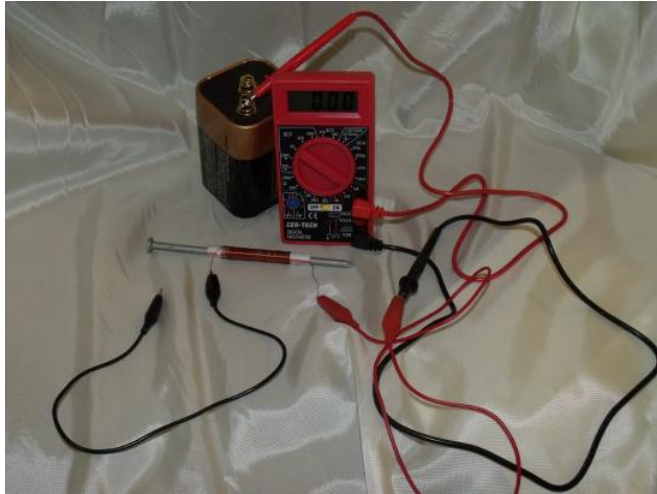
Measure Voltage Load with Multimeter



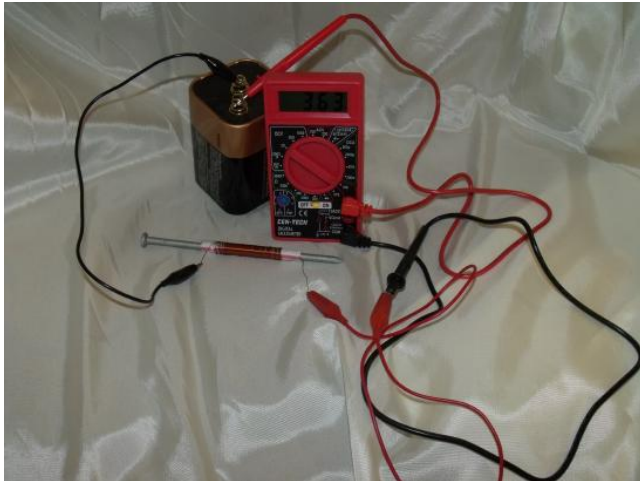
- Connect the meter to the battery and read the voltage
- Connect the electromagnet and see how the voltage drops
- That is energy being drawn from the battery to power the electromagnet
- Disconnect battery, meter and coil



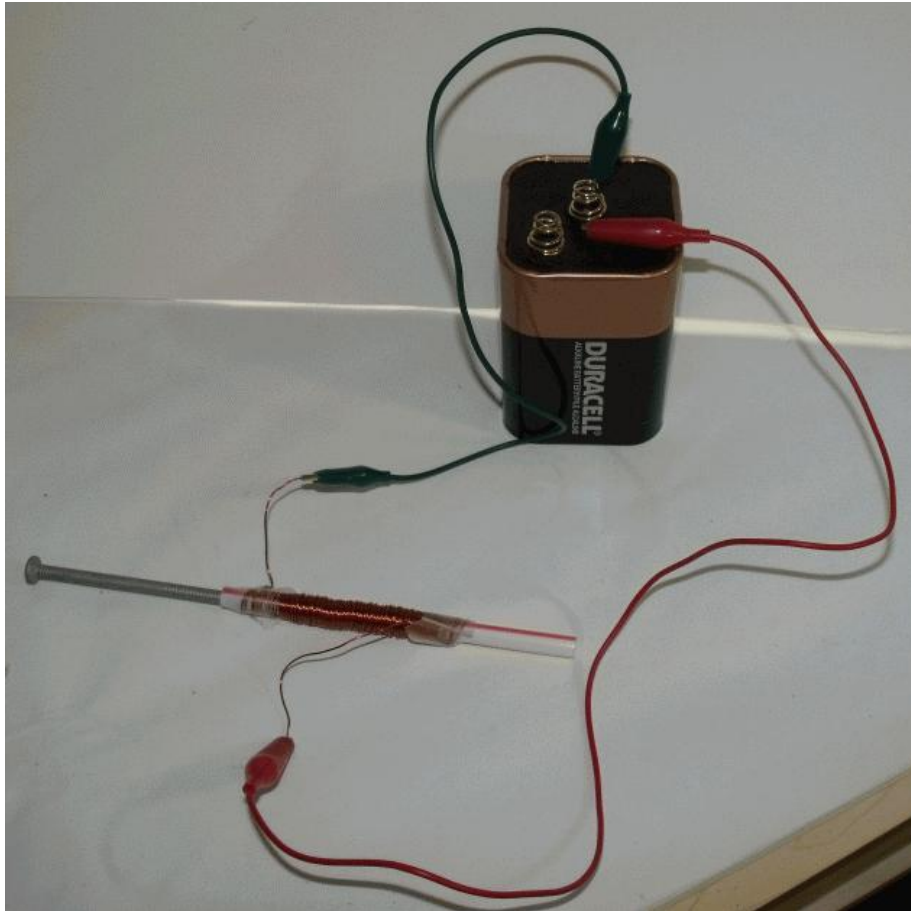
Measure Amperage (Current) Load with Multimeter



- Plug the Red probe wire into 10ADC
- Turn knob to 10A
- Red probe to + on battery
- Black probe to one side of coil
- Wire from other side of coil to - on battery



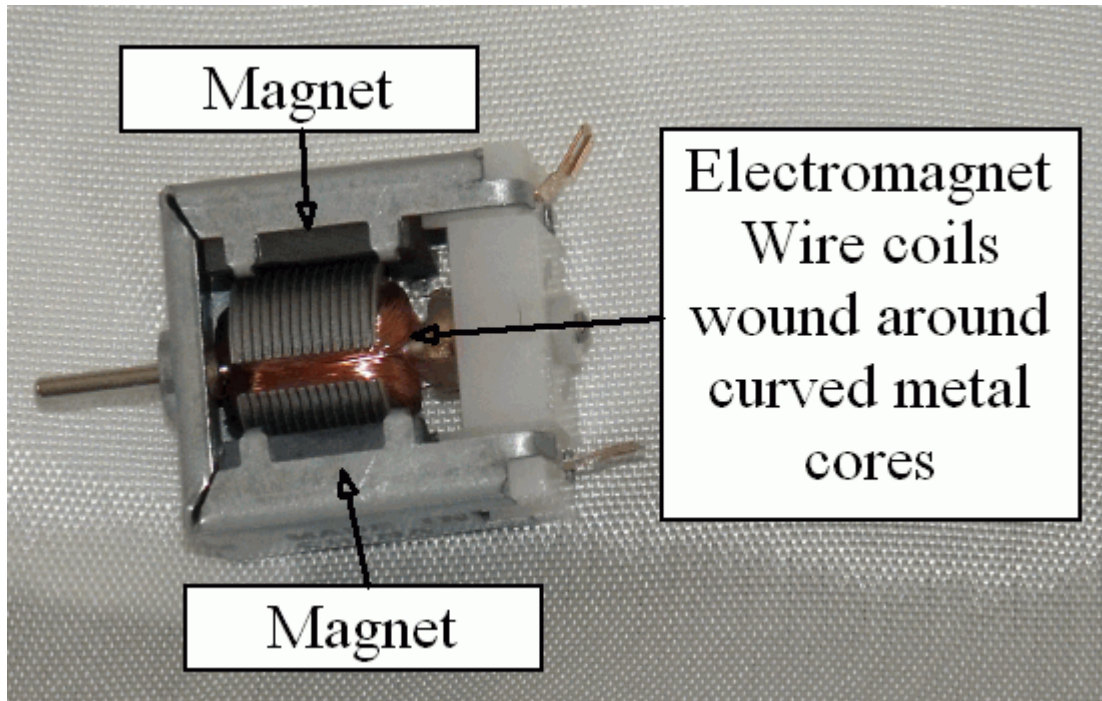
Building a Solenoid



- Disconnect the meter
- Remove the spike
- Put the tip of the smaller nail inside the coil
- Connect the battery again
- The nail is pulled into the coil by magnetic attraction
- Disconnect the battery



Motors



- Coil just like electromagnet
- Magnet that will be attracted and repelled by coil
- Connected to a battery, each coil becomes an electromagnet

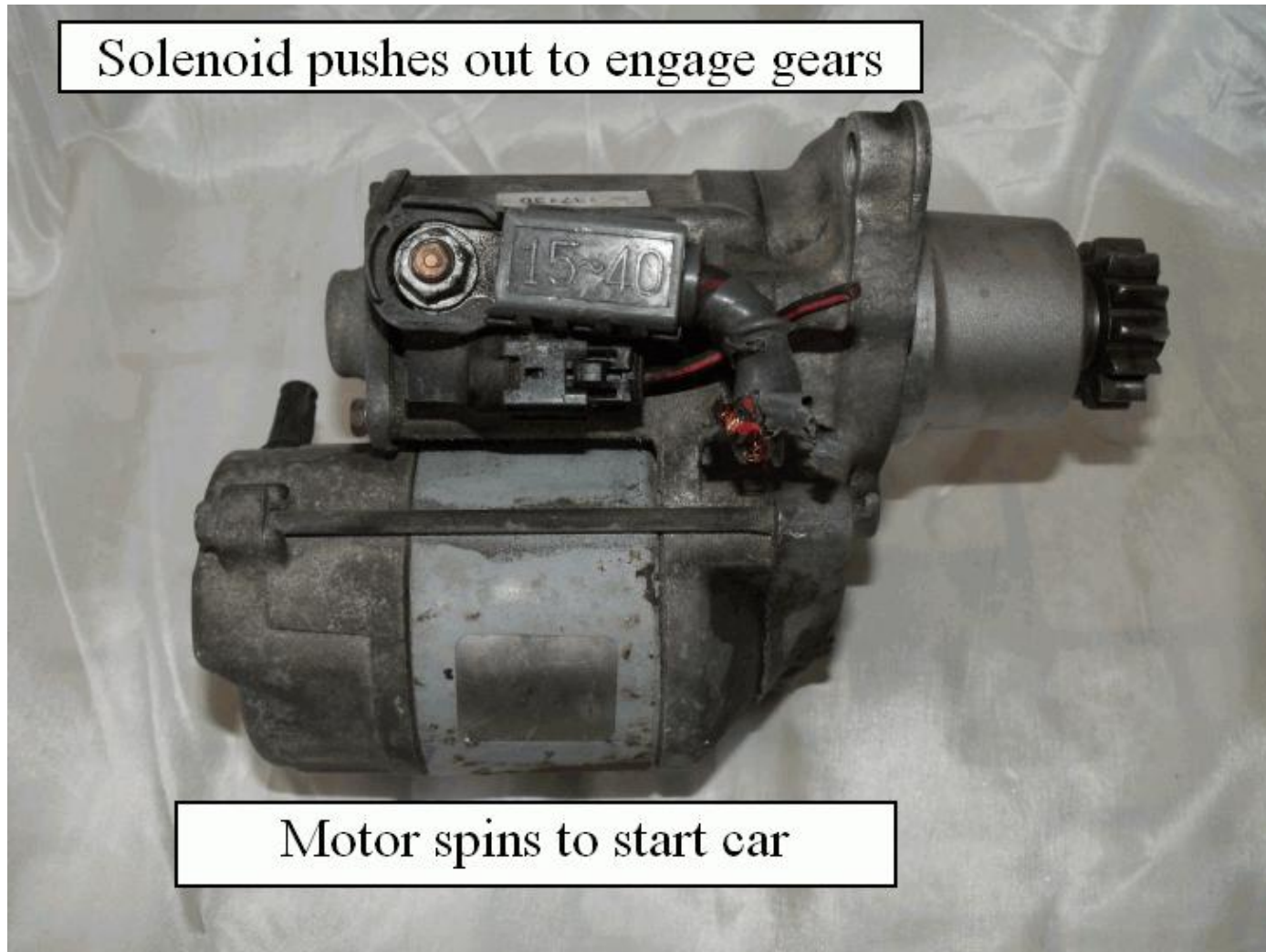


Connecting a Motor

- Check the motor ratings:
 - How many volts maximum?
 - How many amps (current) does it consume?
- Check power source such as battery:
 - How many volts is battery?
 - Use a meter to check if unsure
- Connect just like the electromagnet



Starter Motor and Solenoid from a Car



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Washing Machine Motor



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Disconnect & Pack Up



- Disconnect all the wires
- Put the cap on the middle terminal of the battery
- Put the battery and safety glasses aside
- Put all the other things – magnets, coil, etc. – in the plastic container
- Check the list on the lid and make sure you have everything in it



The Meter is Yours!

- The meter is yours to keep; take it home
- Get the full manual from the Web site
- Find the Web site address on the paper that came with the meter
- Learn how to use it
- It is given to you by the emeritbadge project of IEEE



What We Learned

- ✓ Magnetism is all around us
- ✓ Magnets have poles that attract or repel other magnets
- ✓ Coils of wire connected to a power source are electromagnets
- ✓ Coils can pull and push metal rods to make solenoids
- ✓ Electromagnets and magnets set in a circle become a motor
- ✓ Multimeters are used to measure things electrical

