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University of Illinois • U.S. Department of Agriculture • Local Extension Councils Cooperating

LESSON PLAN

Title: *Exploring Magnetism, Building a Simple Motor*

Lesson Level: *Beginner*

Time Frame: *One hour*

Objectives: *The student will build a small direct current electric motor with direct supervision and instruction, and accompanying slide presentation from CD Rom, "Electrifying Experiments".*

Supplies: *See supply list on slide four of accompanying CD Rom, "Electrifying Experiments".*

Beginning Narrative: **Today we will study the invisible force field surrounding magnets and connected wires. We will harness magnetic energy and build a small direct current electrical motor, with ordinary items like a coil of wire, a magnet and a battery. By the time we are done, you will have built a small motor, powered with electrical energy from a battery and a magnet!**

Electricity Kit Lesson Plan for use with CD Rom, Electrifying Experiments, Lesson One, Exploring Magnetism, Building a Simple Motor.

Slide	*Step by Step Guide / (**Narrative in bold**)*	*What You Do or Show*	*What Participants Do*
1.	This is the title slide		
2.	Supplies that need to be supplied by the instructor or students: flathead screwdriver, wire-strippers, diagonal cutters, needle nose pliers, Phillips screwdriver.	Display tools	View the required tools
3.	Visual representation of finished motor with all components labeled.	Display visual	View visual/slide 3
4.	Material list for instructor/student reference	Display visual	Check that all supplies are present.
5.	Hands-on portion of lesson begins. Make sure each kit has one black and one white wire with alligator clips on each end as shown. Narrative: **"Lets check to see if we have one black and one white wire with alligator clips on both ends of each wire".** (Hold up sample) If they have the wires with clips attached - skip to section/slide 7. If not present, go to section/slide 6.	Ask students to check kit for referenced items.	Check kit for referenced items.
6.	Attach an alligator clip to each end of black bell wire. Repeat for white wire. *Note:* Normally this is already done for you in the 4-H kits. **"It is really important to attach the wires to the alligator clips by twisting in a clockwise motion- so please watch my demonstration before you work with your own materials."**	*If not already done*, ask Students to attach an alligator clip to each end of the black bell wire in clockwise motion. Repeat for white wire.	*If not already done*, attach an alligator clip to each end of the black bell wire in clockwise motion. Repeat for white wire.
7.	Visual instruction of materials to make the rotor; Materials: 1" cardboard tube, enamel wire, and sandpaper. **"The materials that you need to have for this project are displayed on the screen up front** *(if using projector)* **please inspect your materials to make sure you have magnetic copper wire, wooden dowel rod, and sandpaper."**	Display visual of materials needed to make rotor.	View visual- make sure all materials needed are present.
8.	Begin construction of simple rotor made from copper wire**. "We are going to begin building our simple motors! Our first step is to wrap wire around a tube. Watch me show you how to wrap your**	Display visual, demonstrate the actions needed to wrap the wire	Using cardboard tube begin making a coil, Leaving 2" of wire at

	wire."	tightly around the tube.	each end. .
9.	Continue construction of rotor. **Wrap the copper wire around the wooden dowel rod five or six times, leaving at least two inches of unwrapped wire on each end. Make sure you wrap the wire tightly."**	Display visual, demonstrate the wrapping of the tube with wire.	Wrap coils tightly around the tube 5 or 6 times.
10.	Continue construction of rotor**. "Carefully slide the coiled wire off of the tube- keeping the coiled shape intact."**	Display visual, demonstrate the action of removing coils from tube.	Carefully remove coiled wire from tube, keeping the coils held together.
11.	Continue construction of rotor. **"Carefully hold onto one side of your coiled wire and loop one two-inch end of the wire through the coil two times, to secure it, and pull firmly to make sure the loops don't move. Watch me first to make sure you don't collapse the coils you just formed around the dowel rod."**	Display visual, demonstrate the action of Pinching one side of the coil, make a loop with a free end around the coil to secure it.	Pinching one side of the coil, make a loop with a free end around the coil to secure it.
12.	Continue construction of rotor**. "Look closely, now we are going to do the same kind of loop on the other side of our coil. We will take the two inches of uncoiled wire from the second side and loop it through the coil firmly two times to secure it."**	Display visual, demonstrate a second successful coil loop.	Make two loops around the other side of the coil and pull tightly to secure.
13.	Continue construction of rotor. **"Look up at the screen to see an example of a successful coil loop- your coiled wire should look like this when you have finished coiling and looping."**	Display visual, demonstrate 2nd successful coil loop.	Repeat for the other end of coil to secure windings.
14.	Continue construction of rotor. **"Now we need to do some sanding— and this step is really important!! We need to be careful to make sure we follow directions closely! Watch me, and we will take one two-inch end of copper wire and sand all of the enamel, or coating, off of the wire. You should see the wire change colors as you remove the coating with sand paper." ***"Remember to only do one of your wire ends on this step- I don't want to see anyone sanding**	Display visual, demonstrate sanding of one end of copper wire- all the way around the wire. Understand that some students will want to jump ahead and sand the other	Using sandpaper, sand away enamel all the away around one bare, copper end of coil.

	on the second end yet:)"	end as well- it is important that they do not do that—as the other wire is only sanded ¾ of the way around the circumference.	
15.	Finish construction of the rotor. **"The next step is really important too! If we don't follow directions, our motors won't work. We are going to sand the other end of the wire, BUT only ¾ of the way around the wire! We need to leave the coating on the wire in a small strip, so be careful when you sand so that you do not remove ALL of the coating on the wire. If you have questions please raise your hand."**	Display visual, stress the importance of sanding only ¾ of the way around the opposite wire, Leaving an unbroken narrow line of insulating enamel.	IMPORTANT Sand away enamel ONLY 3/4 the away around the opposite end of coil.
16.	Visual inspection of motor mount. **"Good job on those rotors ladies and gentlemen! We are on our way to building a small motor. Now, look at your motor mounts and make sure that the two wood blocks that hold the brass eye screws aren't loose."**	Inspect the motor mount to make sure upright wood blocks are secure and parallel. Check to make sure brass eye screws are present and level.	Inspect the motor mount to make sure upright wood blocks are secure and parallel. Check to make sure brass eye screws are present and level.
17.	Place finished rotor through eye screws. **"Take your rotor and place each end into the "eye" of each eye screw until it is balanced inside the eye screws. If you can spin it freely – it should be correct."** (Demonstrate placing the rotor and spinning it and refer to slide.)	Display visual, demonstrate placing the finished rotor through the eye screws- testing to see if it spins freely.	Place the finished rotor through the eye screws and test to see if it spins freely.
18.	Place magnet between rotor mounts. **"The next step is to place a magnet in between the two upright wooden blocks- look at the picture so you will know where to place the magnet."**	Display visual, demonstrate placing a magnet between the rotor mounts.	Place a magnet equidistant between the rotor mounts.
19.	Wire placement to battery. **"Lets look at our batteries. You will see that the battery has two terminals – one terminal has a + (plus) sign and the other terminal has a – (negative) sign. We are going clip the**	Display visual, demonstrate placing the black wire on the negative	Place the black wire on the negative (-) terminal of a 6-volt battery and the

	black wire onto the negative terminal by pinching open the alligator clip. Then we will clip the white wire onto the positive terminal by pinching open the alligator clip."	(-) terminal of a 6-volt battery and the white wire on the positive (+) terminal.	white wire on the positive (+) terminal.
20.	Wire placement to eye screws via alligator clips. Coil should spin—completing a simple motor. **"The next step is to connect the black wire to one of the eye screws that is holding your rotor. Then clip the white wire to the remaining eye screw. Start your rotor spinning with a gentle push, and it should spin on its own after that. Congratulations! If your motor is spinning you have just created a simple motor!** *(You may need to slightly adjust the placement of you magnet to make your motor run.)*	Display Visual, demonstrate connecting the black and white wires to separate eye screws with the alligator clips. Spin your rotor and motor should take off running.	Connect the black and white wires to separate eye screws with the alligator clips. Spin your rotor and motor should take off running.
21.	**If your motor is not spinning- raise your hand, and I will come and help you get yours running."** *Trouble Shooting Tips if rotor does not spin…* *1.) Check battery. Try a fresh battery.* *2.) Check to see if rotor spins freely and does not hit the wood mounts.* *3.) Move magnet forward or backwards to improve magnetic pull.* *4.) Make sure enamel is sanded completely off one arm of rotor and bare copper touches brass eye. Make sure other arm of rotor has about ¾ of enamel sanded off and only a ¼ of strip of enamel remains on arm.*	*** Note to Instructors: Work with participants in removing enamel from rotor arms as this is a critical stage in the success of making motor run.*	

Summary:

“Our motor is simply one stationary and one spinning/rotating electromagnet. The spinning/rotating magnet is an electromagnet whose poles are changing back and forth constantly, while the stationary magnet keeps its poles the same. Our motor works because the spinning magnet keeps trying to line up opposite poles with the stationary magnet.”