

Teacher Notes-“Circuits And Electromagnets-A Total Inquiry Investigation”

In this special lesson students must complete a series of 4 challenges after being given the objective and a few materials. Your job is stay back and let them figure things out.

When completed, they will have an understanding of circuits and the relationship between electricity and magnetism.

Materials per group (2 students):

- 4 gator clip wires/test leads (item #WW47889M00 at sciencekit.com)
- 2 D-cell batteries (battery holders would be nice too- item #WW46481M00 at sciencekit.com)
- large nail
- 35 cm piece of 20 gauge magnetic wire (shiny red kind, (item #WW47889M00 at sciencekit.com)
- iron filings (item #WW94154M06 at sciencekit.com)
- 2 lights (salvaged from a Christmas Tree strand- cut with ~6cm of tail on each side, and strip off last 2 cm of insulation to expose the copper)
- Funnel- any size
- Small square of sandpaper (~100 grit)

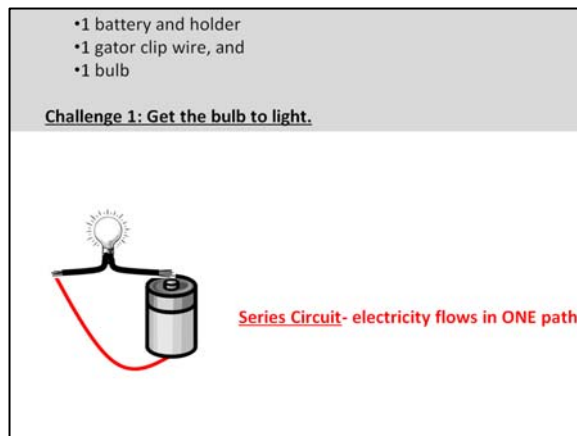
Warning: Electricity is dangerous. Do not allow students to put any of today’s materials into an electrical outlet.

1. Go through materials (listed above), item by item, so everyone knows what’s what, and so you’re sure everyone has what they need.

The easiest way I’ve discovered to keep track of sets of materials is to give each group (2 or 4 students) a plastic shoebox (\$1 apiece at local store).

2. Jump right into the first challenge. In Challenge 1 students have to figure out on their own how to get a light bulb to light with just 1 gator clip wire, 1 bulb, and 1 battery.

You’ll notice that in the PowerPoint (see last



page) I have the materials show first, and then the challenge is presented. I ordered it that way because I found out that when Challenge was presented first, students didn't listen to anything else I said.

3. After revealing the materials and the first challenge, let students work 3-4 minutes on their own without any help from you (except encouragement).

4. Challenge 1 is not very difficult, but a couple of groups might need some help. You can do 1 of 2 things for them- hint that they can look around at successful groups, or you can click ahead in the PowerPoint and show them the diagram.

5. When all students have their bulbs lit, reveal the diagram (if you haven't already) and have them copy. They also need to copy **all words in red** on the PowerPoint. There are other words (in black), but they don't need to copy those.


They can do their writing on the Student Handout (see last page) or on a clean sheet of paper.

•1 battery and holder
•1 gator clip wire, and
•1 bulb

Challenge 1: Get the bulb to light.

•1 battery and holder
•1 gator clip wire, and
•1 bulb

Challenge 1: Get the bulb to light.



Series Circuit- electricity flows in ONE path

6. Challenge 2 will take them a little longer. Begin again with the materials list- 2 batteries, 3 gator clips, and 2 bulbs. The challenge: use these to light 2 bulbs.

7. Be clear and deliberate on the requirements and enforce them- most students will attach more than 1 wire to the ends of the batteries and declare themselves done. This is not allowed. As stated, only one wire can connect to each of the far ends of the batteries. My students never really understood this until I literally stopped class, made them put everything down, and had them hook 1 wire to each of the far ends of the batteries, told them there were no more wires allowed there, then resumed class.

8. Give clues only after students have struggled. *They will remember this much longer if they figure it out themselves, and they will feel much better about themselves if they've had to work through it!*

9. In the diagram the wires are colored differently so students can easily distinguish the 3 wires.

10. Have students draw this diagram (even though it's very similar to our last one) from the PowerPoint on their paper.

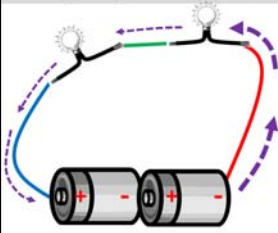
Before moving onto the 3rd challenge, you've got two more things from Challenge 2 that you need to investigate-

1. What happens to the other bulb when one is disconnected? Why?
2. Why is one bulb brighter than the other (this is not very noticeable, but electricity flows from the negative terminal, or bottom, of the battery. After lighting the first bulb, less electricity comes out than went in, and that's what goes onto the next bulb. This is what the funnel from our materials list earlier is for. Hold

- 2 batteries and holders
- 3 gator clip wires, and
- 2 bulbs

Challenge 2: Get TWO bulbs to light

- Batteries must be snapped together end-to-end
- The only things touching the batteries are 1 wire at each end. You may not clip two at one end, or any in the middle!



How many paths are there?

Is one bulb brighter?

it up and ask students to compare how much water goes into it versus how much comes out. This is what's happening here with the electricity.


11. Challenge #3 is more difficult yet: use 2 batteries and 4 gators to light 2 bulbs in such a way that they are independent of each other.

After 2-3 minutes give a clue- show the small lower loop of batteries going to bulb 1 on the PowerPoint.

- 2 batteries and holders
- 4 gator clip wires, and
- 2 bulbs

Challenge 3: Get two bulbs to light INDEPENDENT of each other

- Batteries must be snapped together end-to-end
- The only things touching the batteries are 1 wire at each end. You may not clip two at one end, or any in the middle!



Parallel Circuit- electricity flows in MORE THAN one path

The diagram shows two batteries connected in series at the bottom. Two wires branch off from the top of the battery assembly, each leading to a light bulb. The wires then rejoin at the bottom, completing the circuit. The bulbs are connected in parallel to the battery series.

12. When everyone's got it, have students copy the diagram, term, and definition (in red).

13. If you have at least 10 minutes remaining then you can do Challenge #4: use 1 battery, 1 nail, 1 piece of magnetic wire (about 35 cm) to build a temporary magnet that can pick up iron filings.

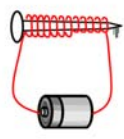
Use sandpaper to sand the shiny red paint off the ends of the wire and expose the copper and conduct when touched to the battery. The wire will not work unless you sand the paint off both ends.

Since this challenge is sort of the “bonus” one, give them no help at all.

When done, copy the diagram and sentences in red.

- 1 battery and holder
- 1 nail
- 1 magnetic wire (shiny red)
- Iron filings (leave in bowl!)

Challenge 4: Build something that will magnetically pick up iron filings



Electricity and Magnetism are inseparable- where there's one you find the other.

The diagram shows a battery at the bottom with two wires extending upwards. The wires are wrapped around a horizontal nail, forming a coil. The wires then extend to the right and connect to the battery terminals.

Come back and visit InteractiveScienceTeacher.com to upgrade this lesson with:


PowerPoint- lead your students through the lesson click-by-click

•1 battery and holder
•1 gator clip wire, and
•1 bulb

Challenge 1: Get the bulb to light.

•1 battery and holder
•1 gator clip wire, and
•1 bulb

Challenge 1: Get the bulb to light.




Series Circuit- electricity flows in **ONE** path

•2 batteries and holders
•4 gator clip wires, and
•2 bulbs



Challenge 3: Get two bulbs to light INDEPENDENT of each other

- Batteries must be snapped together end-to-end
- The only things touching the batteries are 1 wire at each end. You may not clip two at one end, or any in the middle!



Parallel Circuit- electricity flows in **MORE THAN one** path

Student Handout

 Electricity And Magnetism Challenge! 

Challenge 1: _____

Challenge 2: _____
