Avoid the Shock of Shocks! Build Your Own Super-sensitive Electric Field Detector

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p050/electricity-electronics/electric-field-detector (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p050/electricity-electronics/electric-field-detector)

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Experimental Procedure

Notes before beginning:

- Be very careful when assembling this circuit. It is possible to burn out the LED or the transistor by incorrectly connecting them to the 9 V battery. Make sure you carefully count the rows of the breadboard when you assemble your circuit.
- Try to avoid touching the transistor's leads directly, especially the gate lead. Handle the transistor by the plastic packaging when you pick it up. A large static discharge can damage the transistor

Assembling Your Charge Detector Circuit

Important: your Sensor Kit contains two parts that look very similar: a transistor and a Hall effect sensor. They are both small black plastic parts with three metal legs. This project requires the transistor. When viewed from the top, it is bigger than the Hall effect sensor and rounded on one side, as shown in Figure 3. Make sure you use the transistor, or your circuit will not work!

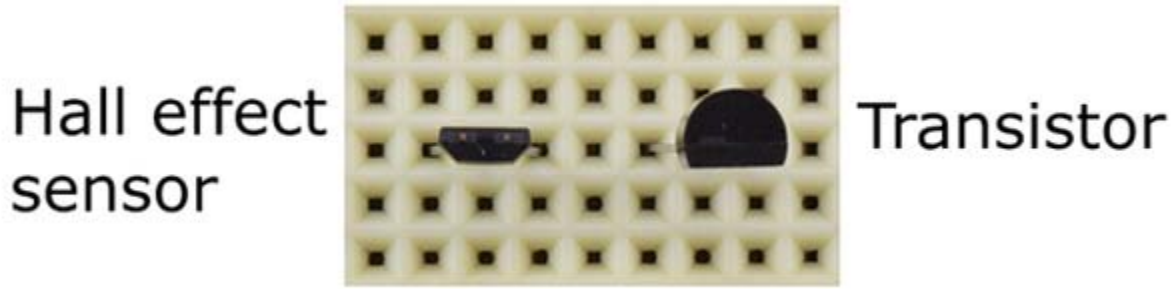
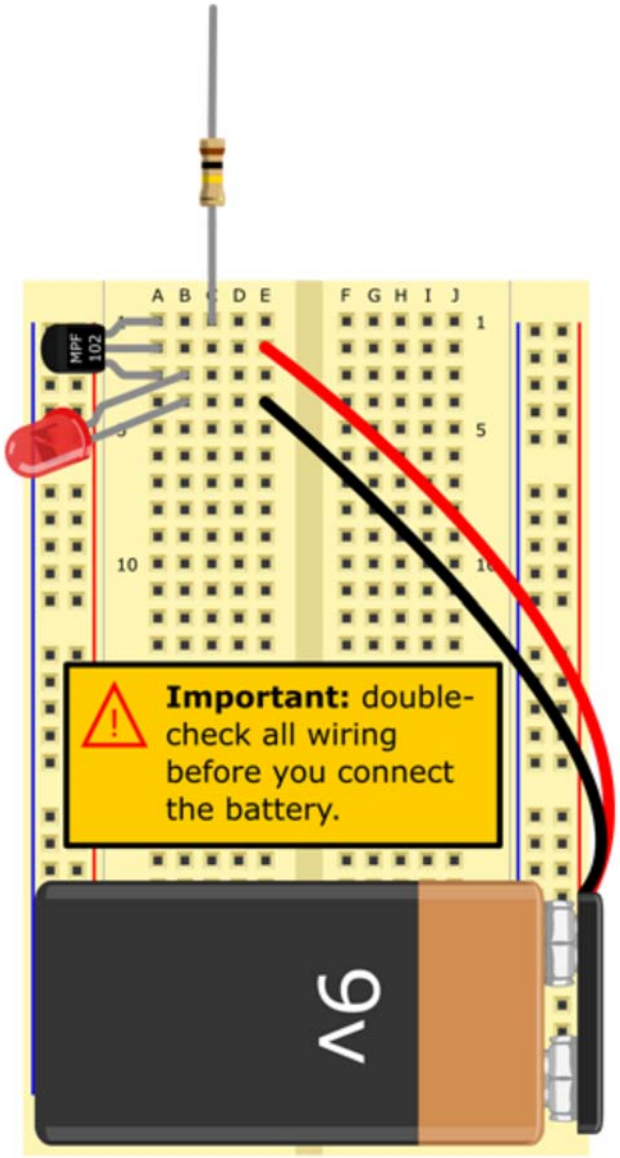


Figure 3. Hall effect sensor (left) and transistor (right) viewed from the top.

Assemble your charge detector circuit on a breadboard, as shown in the slideshow and described in Table 1. If this is your first time using a breadboard, refer to the Science Buddies resource How to Use a Breadboard (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-breadboard). For a circuit schematic, see the Help (#help) section.



Slideshow with step-by-step instructions viewable online.

Part	Picture	Breadboard Symbol	Location
Transistor			A1, A2, A3. Writing must face to the right.
LED			Long lead in B3 Short lead in B4
100 kΩ resistor			One lead in C1
9 V battery and snap connector			Red lead to E2 Black lead to E4

Table 1. List of circuit components and their locations. Source material for breadboard symbol images credit Fritzing.org.

Measuring Electric Fields

1. Learn how to use your charge detector. Once you have finished assembling it, the LED should be on (see Figure 4). Try rubbing different objects from the triboelectric series against each other and bringing them near the "antenna" (the free lead of the 100 kΩ resistor). What happens? Here are some tips for using the circuit:
    a. When you rub two objects together, the one *lower* on the triboelectric series (meaning it has a negative charge) should cause the LED to go out when you bring it near the circuit. The object higher on the series (with a positive charge) may cause the LED to get slightly brighter, but this can be difficult to see since the LED is already on. This project works best if you bring negatively charged objects near the circuit.
    b. The charge on an object will dissipate if you handle it, especially if your hands are slightly damp. By handling the object, the charged particles are

transferred from the object to your skin. You can keep the charge from being lost by isolating the charged object; for example, by quickly placing it on an insulating surface (like a wooden tabletop) next to the circuit, or by suspending the object with string made out of nylon, or some other insulating material.

c. The LED might turn off completely after the circuit is exposed to a strong positive field. You can "reset" the circuit by tapping the resistor leads with your finger, or by waving a negatively charged object (such as a plastic pen that has been run through your hair) near the antenna.
d. See the FAQ (#help) if you have trouble with your circuit.

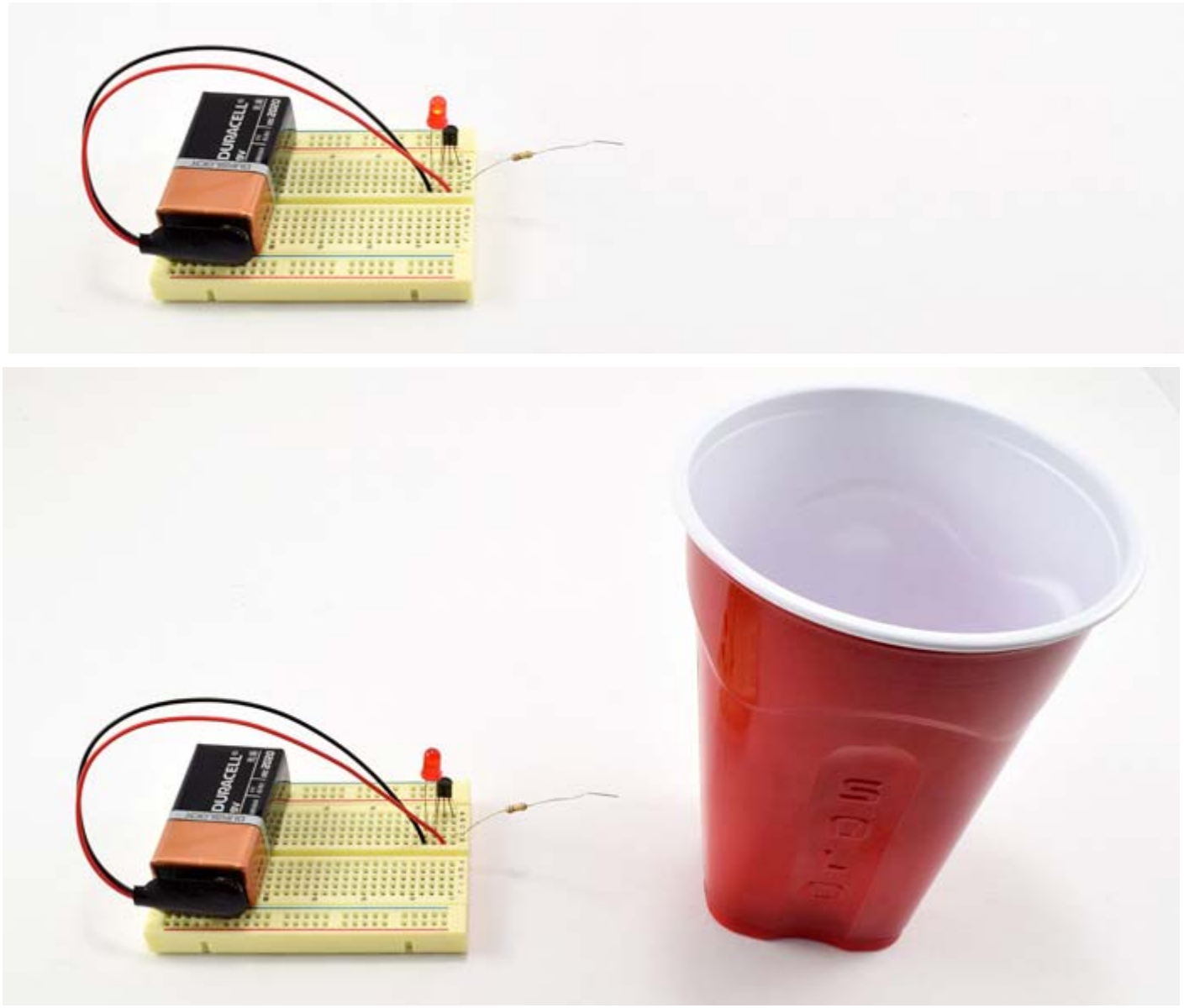


Figure 4. Top: the LED is on when no objects are near the antenna. Bottom: the LED turns off when a negatively-charged object (in this case, a plastic cup that was just rubbed against human hair) is brought near the antenna.

2. Select *one* material from the positive end of the triboelectric series (human hair works well) and an assortment of materials in the neutral and negative parts of the series. You will rub all the other materials against the first one.
3. If possible, prepare all your materials in one place, on a single work surface, so you can do the experiment without walking around. Moving around (especially on carpet) can cause static electricity to build up on your body, and this can affect your results.

4. Rub two materials together and immediately place the negatively charged one directly next to the antenna. Use a stopwatch to time how long it takes the LED to come back on. Repeat this for each of your materials (make sure you rub each material the same number of times), and do at least three trials for each material.
5. Set up a ruler to measure the distance from the antenna. Rub two materials together and then slowly move the negatively charged one toward the antenna until the LED goes out. Record the distance at which the LED goes out. Again, repeat this for each of your other materials and do at least three trials. Remember that the objects might lose charge as you hold them, so you might need to devise a technique to move the objects closer to the antenna without touching them. For example, you could slide them on a wooden block or suspend them from a string.
6. Analyze your data. Which material holds its charge the longest? Which one generates the strongest electric field? If you rank the materials for each category, is the order the same? Are your results consistent with what you would expect based on the triboelectric series?
7. There are many other things you can do with this circuit. See the Variations (#makeityourown) section of this project and the Experiments section of this page (https://www.eskimo.com/~billb/emotor/chargdet.html) for more ideas.

Frequently Asked Questions (FAQ)

FAQ for this Project Idea available online at https://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p050/electricity-electronics/electric-field-detector#help (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p050/electricity-electronics/electric-field-detector#help).