

Measuring Magnetic Fields

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p030/electricity-electronics/measure-magnetic-fields

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Experimental Procedure

Assembling Your Gaussmeter 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 Hall effect sensor. When viewed from the top, it is smaller than the transistor and angled on one face, not rounded, as shown in Figure 2. Make sure you use the Hall effect sensor, or your circuit will not work. There is some writing on one side of the Hall effect sensor (the smaller side). The direction this writing faces is important, but it can be hard to see. Look carefully and try tilting the sensor under a bright light to see which side has the writing.

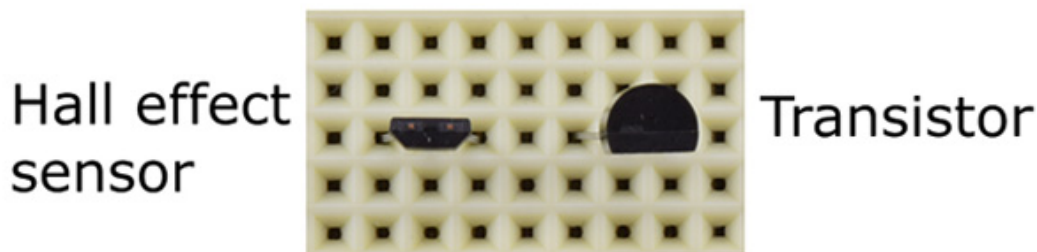


Figure 2. Hall effect sensor (left) and transistor (right) viewed from the top.

Assemble your gaussmeter 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 reference [How to Use a Breadboard](http://www.sciencebuddies.org/science-fair-projects/references/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.

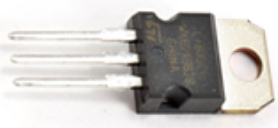









Part	Picture	Breadboard Symbol	Location
Voltage regulator			E2, E3, E4 Writing facing to the left
Hall effect sensor			B9, B10, B11 Writing (smaller side) facing to the left. Look carefully, the writing is hard to see!
Jumper wires (6)			C2 to (+) bus B3 to (+) bus C4 to C9 A10 to (-) bus (-) bus to multimeter A11 to multimeter
9 V battery and snap connector			Red lead to (+) bus Black lead to (-) bus
Multimeter			Set to measure 20 volts DC. Black probe in COM. Connect to ground bus with alligator clip and jumper wire. Red probe in VΩmA. Connect to A11 with alligator clip and jumper wire.

Table 1. Components and their locations in the circuit. Source material for breadboard symbol images credit Fritzing.org.

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1. Once you have assembled your circuit, your multimeter should display about 2.50 V when no magnets are nearby. If you bring a magnet near the Hall sensor, the voltage should fluctuate (whether the voltage goes up or down depends on which pole of the magnet faces the front of the sensor). If the voltage goes all the way down to 0 or all the way up to 5, then your magnet is causing the sensor to saturate, or reach the limits of its range, and you should use a weaker magnet. Experiment with your circuit briefly to see if it is working. If it does not behave as described here, see the [Help](#) (#help) section.
2. Prepare a data table in your lab notebook to record distance between the magnet and Hall sensor, voltage, and magnetic field strength. You may want to pre-determine the distances you will test (for example, every 5 mm).
3. Set up your experiment so you can measure the distance between your magnet and the front of the Hall sensor (the side with the writing on it) using a ruler. Depending on the size and shape of your magnet, you may want to prop it up on something (like a small book) so it is level with the front of the sensor. It is important for the magnet to remain still while you take your readings; your readings may fluctuate too much if you try to hold the magnet in front of the sensor. Figure 3 shows an example experimental setup.

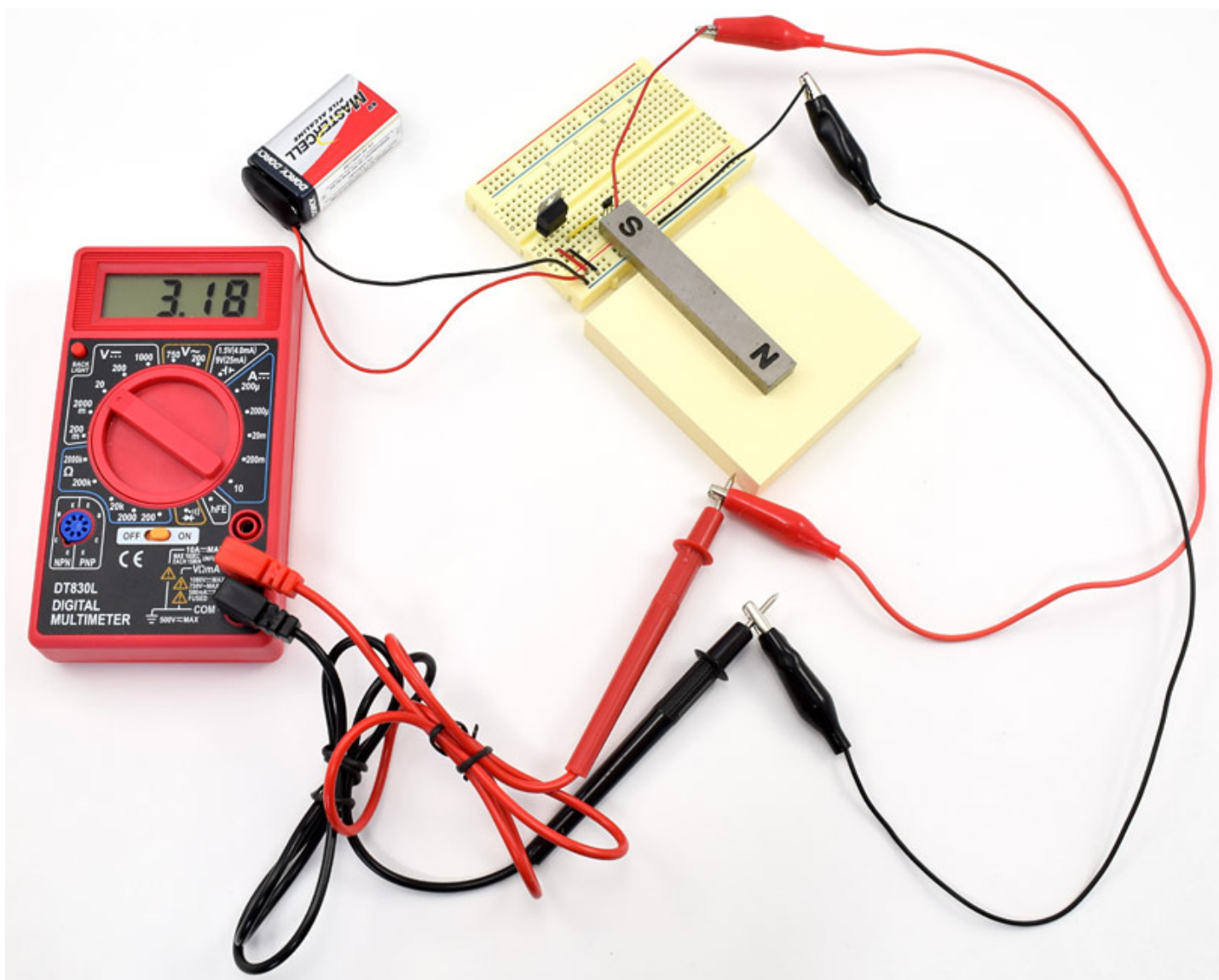


Figure 3. Experimental setup to measure the effect of distance on magnetic field strength. A stack of sticky notes is used to hold the magnet level with the front of the Hall sensor.

4. Make sure the sensor is not near any magnets. Record the voltage displayed on the multimeter in your lab notebook and label it as " V_0 ". Refer to the Science Buddies reference [How to Use a Multimeter](http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter) (<http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter>) if you need help using a multimeter.
5. Now, starting with the magnet touching the face of the sensor (a distance of zero), record the voltage displayed on the multimeter.
6. Slide the magnet directly away from the sensor (make sure you move it straight backwards, not to the side). Record the new distance and voltage in your data table.
7. Repeat step 6 until the voltage stops changing.
8. Repeat steps 5–7 at least two more times, for a total of at least three trials.
9. Calculate an average voltage for each distance.
10. Now, convert voltage to magnetic field strength. You can do this using information from the sensor's [datasheet](http://www.avantlink.com/click.php?tt=cl&mi=10609&pw=182414&ctc=measure-magnetic-fields&url=http%3a%2f%2fwww.jameco.com%2fJameco%2fProducts%2fProdDS%2f2135881.pdf%3favad%3d182414_cb3e21ee%26source%3dAvantlink) (http://www.avantlink.com/click.php?tt=cl&mi=10609&pw=182414&ctc=measure-magnetic-fields&url=http%3a%2f%2fwww.jameco.com%2fJameco%2fProducts%2fProdDS%2f2135881.pdf%3favad%3d182414_cb3e21ee%26source%3dAvantlink), which says that the sensor has a sensitivity of 1.3 mV/G (note that the sensitivity is given in *millivolts* (mV) and you took your readings in volts (V), so you will need to convert from V to mV). You can convert voltage to field strength using the following equation:

Equation 1:

$$B = \frac{V_0 - V}{1.3}$$

where

- **B** is the magnetic field strength in gauss (G).
- **V_0** is the voltage when there is no magnet nearby in millivolts (mV).
- **V** is the voltage recorded at a certain distance in millivolts (mV).

- **1.3** is the sensor's sensitivity in millivolts per gauss (mV/G).

Note that it is okay if the value you calculate is negative. See the [Help](#) (#help) section for more information.

11. Make a graph of magnetic field strength versus distance.
 - a. How does field strength change with distance?
 - b. Are your results consistent with the behavior you observe when using magnets? In other words, can magnets push and pull on each other from across a room? How close do you need to bring them before they will snap together on their own?

Frequently Asked Questions (FAQ)

FAQ for this Project Idea available online at

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p030/electricity-electronics/measure-magnetic-fields#help.