Pencil Resistors

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p013/electricity-electronics/pencil-resistor (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p013/electricity-electronics/pencil-resistor)

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Experimental Procedure

1. Watch this video for an introduction to your Basic Circuits Kit.

   Setup instructions for your Basic Circuits Kit.
   https://www.youtube.com/watch?v=a917_y_oxkA (https://www.youtube.com/watch?v=a917_y_oxkA)

2. Set up your test circuit, as shown in Figure 4.
   a. Insert three AA batteries into the battery holder (your kit comes with one extra battery). Make sure the "+" symbols on the batteries line up with the "+" symbols inside the battery holder.
   b. Connect a red alligator clip to the exposed metal part of the red wire from the battery holder (in electronics, red wires are usually used for the "positive" connection).
   c. Connect a black alligator clip to the exposed metal part of the black wire from the battery holder (in electronics, black wires are usually used for the "negative" connection).
   d. Attach the other end of the black alligator clip to one of the screws on the lightbulb holder. If necessary, use a small Phillips head screwdriver to loosen the screw slightly, so it is easier to clip to.
   e. Screw the lightbulb into the bulb holder.
   f. Attach one end of the green alligator clip to the other screw on the bulb holder.
   g. You will connect your pencil resistors to the free ends of the red and green alligator clips.
   h. Test your circuit by touching the exposed metal ends of the red and green alligator clips together. This creates a closed circuit and your lightbulb should light up. If it does not light up, then check the following:
      i. Make sure the lightbulb is screwed tightly into the base.
      ii. Make sure none of your alligator clip connections are loose.
      iii. Make sure none of your batteries are backwards.
   i. **Important:** throughout the project, only connect the lightbulb for long enough to assess its brightness, then disconnect it when not in use. Leaving the lightbulb connected for a long time can cause it to burn out prematurely.

Figure 4. The test circuit for this experiment. The twist ties are not required, but they can help keep your circuit neat by bundling up the alligator clip leads.

3. Decide how many pencils you want to test. You can choose the lengths you test, but they should range from very short to almost the full length of the pencil, in regular intervals. For example, you could cut pencils to lengths of 4, 6, 8, 10, 12, and 14 centimeters (cm). Do not worry about changing the length of the pencils after you sharpen them; you will measure their final lengths.
4. Have an adult help you use a ruler and a saw to cut pencils to the lengths you decided.
5. Use the pencil sharpener to sharpen both ends of the pencils, like in Figure 5.

Figure 5. Pencil resistors of various lengths sharpened at both ends.

6. Create a data table like Table 1 in your lab notebook.
7. User a ruler to measure the tip-to-tip lengths of your sharpened pencils, and record these lengths in your data table.

Pencil Length (cm)	Bulb Brightness
0	

Table 1. Example data table.

8. Now you are ready to start your experiment. Touch the exposed metal ends of the red and green alligator clips together. This is your "control" trial. In the first row of your data table (for resistor length of 0 cm), record how bright the lightbulb is (for example, you could use a scale from 0–5 where 0 is "off" and 5 is "very bright"). Disconnect the alligator clips as soon as you are done.
9. Next you will test each one of your pencil resistors. Connect your shortest pencil resistor to your circuit using the red and green alligator clips, as shown in Figure 6.

Figure 6. Connect red and green alligator clips to the graphite point at each end of a sharpened pencil.

10. Observe the brightness of the lightbulb, and record the brightness in your data table using the same scale you used in step 8. Remember not to leave the bulb connected when not in use, as this will cause it to burn out sooner.
11. Repeat steps 9–10 for each one of your pencil resistors.
12. So far you have only completed one trial for each pencil resistor length. Most science fairs require multiple trials for an experiment. If necessary, add columns to your data table for second and third trials, and repeat the experiment.
13. Analyze your results.
    a. How does bulb brightness change as the length of the pencil resistors increases?
    b. Make a graph of your results with resistor length on the horizontal (x) axis and bulb brightness on the vertical (y) axis.
    c. How does resistance affect the brightness of the bulb? To answer this, you will need to decide whether longer pencils have higher or lower resistance.
    d. How does resistance affect the amount of current flowing through the circuit? *Hint*: Would more current flowing through the lightbulb make it brighter or dimmer?

Frequently Asked Questions (FAQ)

FAQ for this Project Idea available online at https://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p013/electricity-electronics/pencil-resistor#help (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Elec_p013/electricity-electronics/pencil-resistor#help).