How Do You Take Your Tea? Make a Simple Electronic Device to Measure the Strength of Tea

https://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci_p058/cooking-food-science/electronic-device-to-measure-the-strength-of-tea (http://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci_p058/cooking-food-science/electronic-device-to-measure-the-strength-of-tea)

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Experimental Procedure

1. Make your light-measuring device by wrapping a clear plastic cup in aluminum foil and taping a photoresistor (Figure 1) to the bottom with electrical tape, as shown in Figure 2.

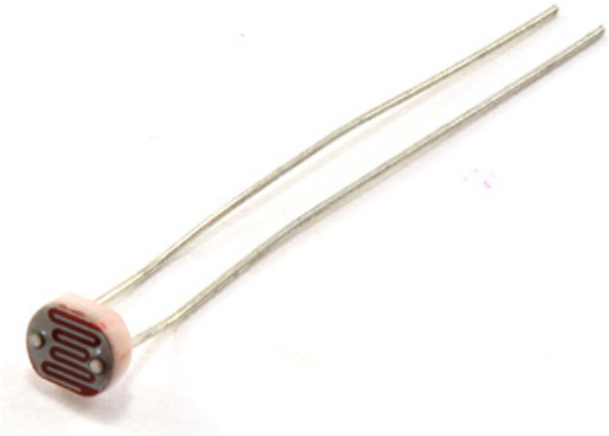

Figure 1. Picture of the photoresistor in your kit.

   a. Wrap aluminum foil around the sides of the cup and secure it with electrical tape.
   b. Bend the leads of the photoresistor sideways.
   c. Tape the photoresistor to the bottom of the cup so it is facing up (the side with the squiggly line should be pressed against the bottom of the cup). Make sure the leads of the photoresistor stick out from under the edge of the cup, since you will need to connect to them with alligator clips later.
   d. **Important:** do not let the leads of the photoresistor touch the aluminum foil. Make sure to insulate the aluminum foil and the leads with electrical tape. Otherwise you will create a **short circuit** and the resistance of your photoresistor will always read zero.

Figure 2. Three different views of a plastic cup covered in aluminum foil, with photoresistor attached at the bottom using electrical tape.

2. Prepare 15 mugs: 3 mugs of water, and 3 each of tea with brewing times of 10, 30, 90, and 270 seconds. Use *exactly* the same amount of water for each mug.
   a. Note: if you do not have 15 mugs or glasses available, you can just do 5 at a time (one for water and one for each brew time), then wash and dry them and repeat the experiment.
   b. Boil water in a pot or tea kettle. It is important to start each sample with water at the same temperature. If you need to add more water as you prepare your samples, always wait for it to start boiling again before you prepare the next mug of tea.
   c. Use masking tape and a permanent marker to label 15 mugs with the brewing times (or "water only").

d. Place a tea bag in each mug.
e. Decide how much water you will use for each mug of tea. It is important that this amount be *exactly* the same for each mug, since the depth of the water will affect how much light is absorbed. For example, you could use 200 mL if you have metric measuring utensils (or 1 cup (C) if you have English measuring utensils).
f. Pour exactly 200 mL of water into 3 of the mugs.
g. Prepare your stopwatch.
h. Use the measuring cup to pur exactly 200 mL of boiling water into a mug and start your stopwatch. Get help from an adult if you are not comfortable measuring and pouring hot water.
i. Remove the tea bag after 10 seconds.
j. Repeat steps 2f–2h for each of the remaining mugs, preparing three samples for each brewing time.
k. Allow all of the mugs to cool to room temperature before you continue.
l. Transfer the contents of each mug to a clear plastic cup, as shown in Figure 3. Label the cups with a permanent marker so you do not lose track of the brewing times.

Figure 3. A plastic cup of just water, and cups of tea with brewing times of 10, 30, 90, and 270 seconds. For your project you should prepare three samples of each.

3. Measure the resistance of the photoresistor for each sample by placing the sample cup inside the aluminum foil-lined cup.
   a. Set up your experiment in a room with good overhead lighting, and with as few disturbances in lighting as possible. The photoresistor is very sensitive, so variations in sunlight coming through a window on a cloudy day, or even shadows and reflections created as people walk around the room, can all affect the readings.
   b. Tape the aluminum-foil covered cup down in one spot so it does not move throughout the duration of your experiment. That will ensure that it receives consistent lighting.
   c. Set up your multimeter to measure the resistance of the photoresistor, as shown in Figure 4.
      i. Plug the black multimeter probe into the port labeled COM.
      ii. Plug the red multimeter probe into the port labeled VΩmA.
      iii. Connect the multimeter probes to the leads of the photoresistor using alligator clips. Make sure the metal parts of the alligator clips do not touch the aluminum foil, or this will create a short circuit.
      iv. Set the multimeter dial to measure resistance in the 20 kilo-ohm (kΩ) range.
      v. Turn the multimeter's power switch to ON.
      vi. If this is your first time using a multimeter, see the Science Buddies resource How to Use a Multimeter (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter), particularly the section How do I measure resistance? (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter#qmultimetermeasureresistance) to learn more.
   d. Place your first sample cup inside the aluminum foil-covered cup.
   e. Record the resistance of the photoresistor in your lab notebook. Remember to pay attention to units. If your multimeter dial is set to "20k", then your resistance measurements are in kilo-ohms (kΩ).
   f. Note: if your multimeter screen reads "1 .", then the resistance is too high for the current dial setting. Rotate the dial up to "200k" and try again.
   g. Repeat steps 3d–3f for each of your remaining sample cups.

Figure 4. Experimental setup for measuring the strength of tea.

4. Analyze your results.
    a. Make a data table with the resistance readings for each sample.
    b. Calculate the average resistance for each brew time.
    c. Subtract the value of the negative control (cup of water) from the other values.
    d. Graph the average resistance, in ohms, on the y-axis vs. time (in seconds) on the x-axis.
    e. Discuss the shape of the curve. Is it a straight line or something else?
    f. What does this tell you about the relationship between brew time and how much light the tea absorbs? If you increase the brew time, will the resistance of the photoresistor increase forever, or will it eventually reach a maximum?