Resistance Board

// Ohm's Law Board (Experiential Teaching Tool with LilyPad)

Looking for any easy way to explain the concept of Resistance? Why waste time explaining and going over boring equations when you can easily create a project that will show what resistance is with some 2-ply conductive thread, a switch, a 3.7V 1000mAh battery, some velcro, a 10 -12 foot two by eight piece of wood and 5 LilyPad LEDs?

The idea is simple enough. The conductive thread has a certain amount of resistance per foot. If you string up a bunch of LEDs on the conductive thread the farther the LEDs are from the power source the more thread the electricity must travel through. The more thread the electricity has to travel through the more resistance it encounters. The more resistance the electricity encounters the more voltage is required to travel beyond the resistance. Since there is only a certain amount of voltage in our battery we can only light up a certain amount of LEDs. We know from Ohm's Law that if the voltage is staying constant and the amount of resistance is increasing then the amount of current must decrease. Therefore the position of these LEDs on the thread (closer or farther from the battery) affects the amount of current present for creating light. Uh... you may be asking what happened to simple? Put together the resistance board below for a demonstration that is really easy to understand.

First drill four screws into a ten foot two by eight inch board. The screws should be placed in pairs at either end of the board about an inch apart. Leave six to twelve inches between one of the sets of screws and the end of the board for your switch and battery.

Now string up the LEDs on two pieces of thread. Make sure you string the positive sides of the LEDs all on one piece of thread and the negatives with the other, it's not a big deal if you get one or two switched, but you will need to untie everything in order to fix them.

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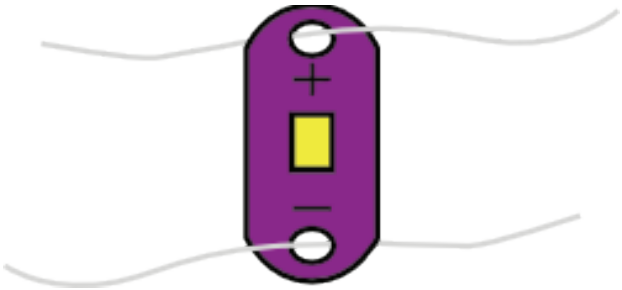
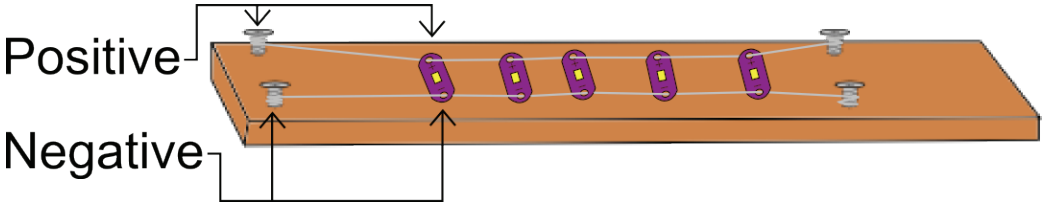
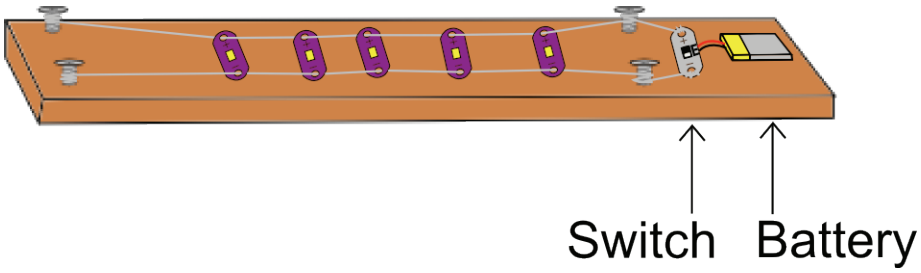
Don't loop the thread through the positive and negative holes over and over again; just thread it through once. This way you will be able to change the position of the LEDs by sliding them up and down the thread. The last thing to note about threading up the LEDs is that you will want to send the thread through the positive and negative holes in opposite directions. So, if you've threaded the positive side from the top to the bottom, go from the bottom through to the top on the negative side. This way the tension of the thread will keep the LEDs flat and provide good connections, which is very important for conducting electricity.



After making sure that the LEDs are correctly threaded then attach each end to one of the screws, make sure not to cross the threads. When tying off the threads draw the thread tight, but not so tight that you will have a hard time moving the LEDs up and down. Also leave a good three to four inches hanging off each nail at the end you intend to connect to the power source.



Now glue the switch to the board about an inch away from the sets of screws you will attach to your power source. Orient the switch so the positive and negative sides are aligned with your LEDs. Then tie both loose ends of thread to the correct sides of the switch. Attach your velcro to the back of your battery and to your board near the switch. Now plug your battery into the lilypad switch and turn it on. If everything is connected properly you now have a really effective way to teach about resistance. Move the LEDs closer and farther away from the battery for more or less light.



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In our example SparkFun created two circuits of different lengths because we have two different gauges (thickness) of conductive thread. The thicker the conductive thread the less resistive the circuit and the more current it can carry. So our thicker thread resistance board is twice the length of the example above, has more LEDs attached to it (a total of seven) and is lit up way brighter than the LEDs on the board with the thinner thread.

For the math on how the relationship between resistance, voltage and current work look up Ohm's Law. It's one of the most basic building blocks of electrical calculation.

To figure out how long your battery will last use this equation:

$$Battery\ run\ time = \frac{milli-\ Amp\ hour\ of\ the\ battery}{total\ milli-\ Amps\ of\ the\ circuit}$$

We know that each LED uses 20mA (you can measure using a multimeter or look at the datasheet), so the total Amps of the circuit is 20mA * 5. Find the Amp hour of the battery (hint, it's at the very beginning of the tutorial) and plug all these numbers into the equation above.