Ohm's Law

Directions and Suggestions for Teacher

Purpose:

This lab is designed to give students hands-on experiences with Ohm's Law as well as building a simple circuit and reading the color codes on resistors. I highly recommend doing a live part to this virtual lab that mirrors as closely as possible what is done in this program.

Virtual Part:

(https://thephysicsaviary.com/Physics/Programs/Labs/OhmsLawWithPredictionsLab/)

This lab can easily be paired with a live lab that mimics the virtual lab. It is important to give the students a hands-on experience as frequently as possible.

Measuring Resistance:

Students click on the first two bands on the resistor to change the resistance of the resistor. It is important to emphasize that we are only changing the first two bands so that a good looking graph can be produced from our data. When doing the live part of the lab, don't allow too big a change in the magnitude of the resistance or the graph will be very hard for the students to deal with.

Measuring Current:

Students should use the analog meter that is connected in series with the resistor to estimate the current flowing through the circuit. Students should make sure they record their current in Amps regardless of what it is measured in using the meter.

Working Through the Lab:

Students will be changing the resistance of the resistor for each trial. A nice range of resistances should be used, but I would suggest the maximum resistance should be no larger than ten times the minimum resistance. I would suggest students do at least 5 different resistors with 10 resistors being even more ideal to get a good looking graph.

The program will randomize the voltage of the battery, so all students will get different results. Students should not refresh the website while working or it will generate new values and thus make all the old data irrelevant. Below is a sample of what potential data might look like.

Data:

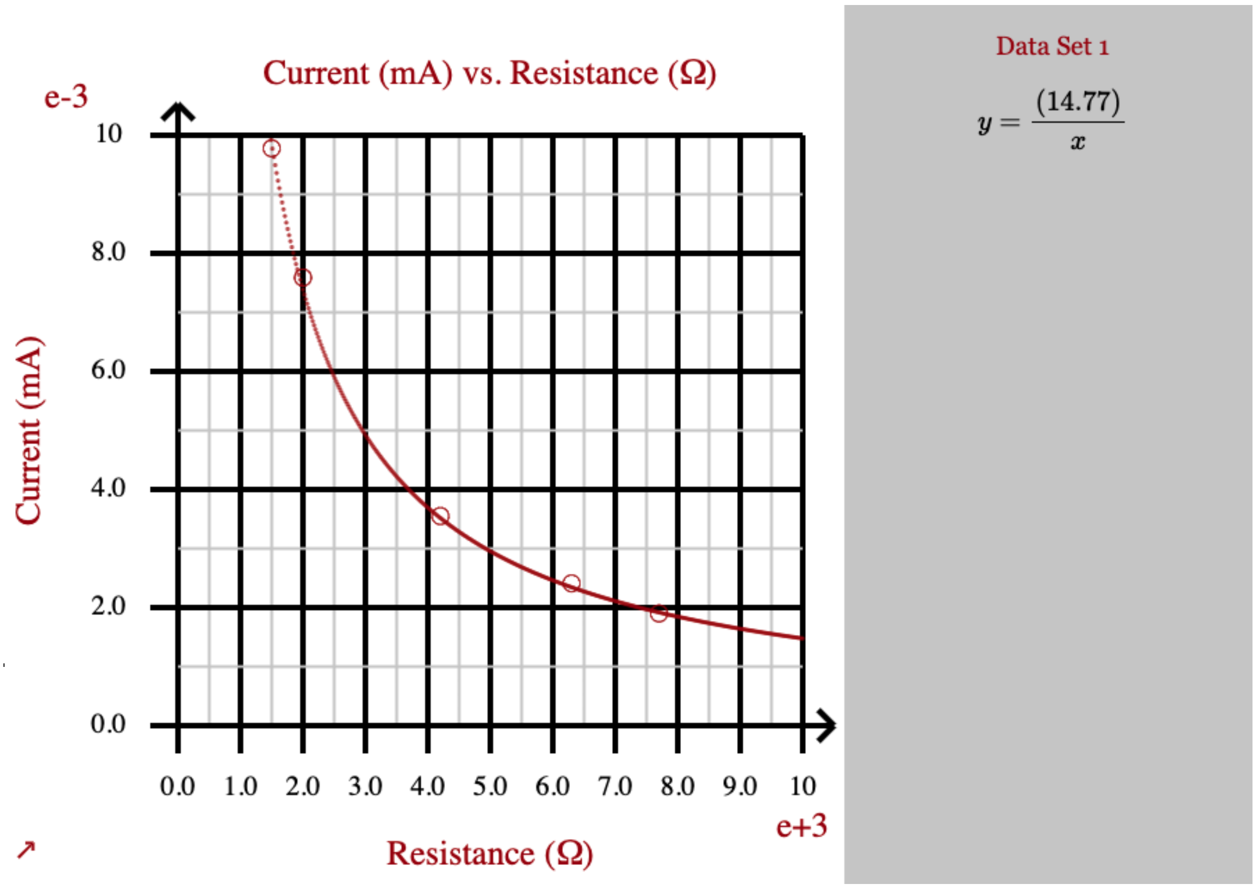
Colors	Resistance (Ω)	Current (A)
Red, Black, Red	2000	0.00759
Brown, Green, Red	1500	0.00978
Violet, Violet, Red	7700	0.00190
Blue, Orange, Red	6300	0.00241
Yellow, Red, Red	4200	0.00355

Graphing Data:

(https://www.thephysicsaviary.com/Physics/Programs/Tools/Graphing/)

Once students have finished collecting data, they should graph it and find a relationship between the variables. The resistance in Ohms is the independent variable and should be placed on the x-axis and the current in the circuit in Amps should be on the y-axis. This graph should come out to be an inverse graph.

I prefer always having the students transfer their graph onto their lab sheet by hand.



This lab was created by Frank McCulley for thephysicsaviary.com.

Equation:

For this graph students get an inverse relationship between the variables. This indicates to them that a larger resistance will cause the current to decrease. Doubling the resistance will cause the current to be cut in half.

The equation for an inverse relationship is given below.

$$y = A/x$$

We want to continue to emphasize to them the idea that each of these letters has real physical significance. Looking at the axes, they should see that the y is the current and the x is the resistance. So the equation becomes:

$$I = (\text{graph constant})/R$$

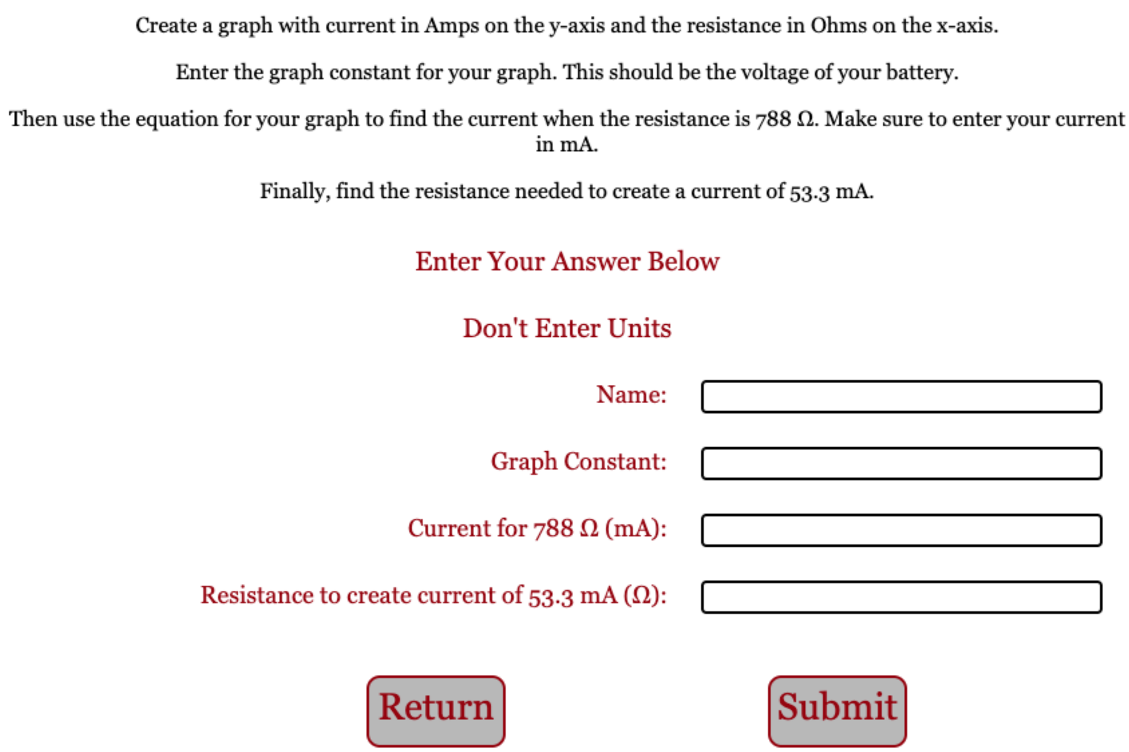
We then want students to think about the significance of the graph constant. We can prompt them by asking what other things about the circuit played a role in terms of determining the current measured by the meter. Hopefully a few of the students will realize that the voltage of the battery would have an effect on the current. At this point you can tell them that the graph constant in this equation is equivalent to the voltage of the battery so that the final equation becomes:

$$I = V/R$$

Checking their work:

Once the students have reached the point where they have graphed and created an equation, they will then be able to check their work. They should simply hit “Finished” on the program to be brought to a form they can fill out to see if they did everything correctly. Remind students that they all will be getting different answers and that they shouldn’t worry if their answers differ from those of their classmates.

Make sure to stress that they should have graphed the current in amps. They will be entering their value from their graph as the graph constant. They will then use their equation to make a prediction on how much current would flow through the wire for a resistance value which they didn’t collect data on. Finally, they will be asked to calculate the resistance that would be needed to create a desired current..


Create a graph with current in Amps on the y-axis and the resistance in Ohms on the x-axis.

Enter the graph constant for your graph. This should be the voltage of your battery.

Then use the equation for your graph to find the current when the resistance is 788 Ω. Make sure to enter your current in mA.

Finally, find the resistance needed to create a current of 53.3 mA.

Enter Your Answer Below

Don't Enter Units

Name:

Graph Constant:

Current for 788 Ω (mA):

Resistance to create current of 53.3 mA (Ω):

Return

Submit

I would normally offer a small amount of extra credit added to the lab grade if they get all their answers correct. I would have them show me their completion certificate so I could record that they earned the extra credit. If a student doesn’t get everything correct, you can have them redo the lab by refreshing their page if time permits.

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Live Part:

I would have the students complete a live part that is almost identical to the virtual part they have just completed. Make sure they know how to use whichever current meter you have available and that the circuits they build are constructed so that the current meter is connected in series with the resistor and the battery. Finally, make sure the resistors you use are of the appropriate resistance so that you don't blow a fuse in the meter.

It is important that the resistors that the students have to choose from are all of the same magnitude. You don't want the maximum resistance to be more than 10x the value of the minimum resistance.

The equipment I would use for this setup is shown in the picture below:

Conclusion:

I personally like to have students write out a conclusion by hand after they are done with the entire lab (live part and virtual part). Some things you can have students include in the conclusion.

1. **Restatement of the purpose.**
    a. This is a great way to open the conclusion
    b. It helps to reinforce the reason we were doing the lab.
2. **Brief Summary of the steps**
    a. I don't want too much here but I do want students to transition from the purpose to the results with a sentence or two summary of the steps.
    b. This part of the conclusion should paint with a very broad brush what type of data we were collecting and what remained constant when collecting data.
3. **Results**
    a. I want students to clearly state what type of relationship existed between the two variables we were examining.
    b. I want them to clearly explain what this means in simple to understand terms.
    c. Basically, they will be making sense of the equation they have discovered in the lab.
4. **Error**
    a. They should talk about their percentage of error from the lab (you can have them do this for the live part or the virtual part or both).
    b. They should brainstorm at least one possible source of that error and how it can be minimized if they redid the lab.
5. **Limitations to the model**
    a. Whenever possible I want them to think about when the mathematical model for the lab would break down and no longer apply.
    b. For instance, with this lab, the equation they create would break down if the amount of current was greater than the amount that could be reasonably supplied by the battery without being affected by the internal resistance of the battery.
    c. Another factor that could limit the accuracy of our predictions is the error that might exist in the resistors themselves. The value determined by the color code is an approximation of the actual resistance and even that value might change a bit with the temperature of the resistor.

Going Further

If you have the time, you could challenge the students with the following types of things.

1. How would your graph change if we collected data using a different battery? Have the students sketch lines on their graph that would be representative of a higher voltage and lower voltage power supply. If time permits, have the students actually collect data again using a different voltage battery.