GOAL: Find the internal resistance of the 9-Volt battery in the DC Construction Kit.
(even though you already know it!)

METHOD: Change the resistance in the circuit and measure the current and voltage drop across the terminals. You should collect data for at least 10 different resistances only using combinations of the 10-Ω resistors. The total resistance should not exceed 30-Ω. Set the slider for the internal resistance to 1-Ω. The uncertainty of each resistor is ±0.1-Ω.

Use LoggerPro to graph V vs. I. Make sure you graph the correct variable on the correct axis, so that the slope is meaningful. You do not need to include error bars.

We have learned that the emf (ε) = the terminal voltage (V_t) with current flowing + the voltage drop due to internal resistance (V_r). Use ONLY the graph and the equation $V_t = \varepsilon - V_r$ or $V_t = \varepsilon - Ir$ (no calculations) to obtain a value for the internal resistance (r) and the emf (ε). Feel free to rearrange the equation so that the terms match features of the graph.

WHAT TO TURN IN:

DATA: Paste a screenshot of your data table and graph into a Googledoc. Label your axes correctly with units. Fit a linear regression line to the data points and make sure the equation is large enough to be visible (20 pt font).

CONCLUSION: Clearly state the value for the battery internal resistance (r) with units using the uncertainty provided above, reported to the correct level of precision. Clearly state the value for emf (ε) with units.

CONCEPTUAL CONNECTION(s): Although you knew the internal resistance of the battery to start with, the important part of this lab is your ability to connect the data taken, the graph generated (and its equation) conceptually to the goal of the lab. We might have been back at Nido, working with real batteries. Briefly answer the following questions:

Q#1: How would you have done this lab then without knowing r at the beginning? Let's say you also are not allowed to measure emf (ε) directly on the unconnected battery? How would you find it then? What part of the graph gives you the value for r? What part tells you the value for ε? How do you relate these to the equation for the line?

Q#2: Was working with all known values easier in terms of reinforcing the concepts or more difficult? Other than having fun messing around with nerdy lab supplies (my favorite part), what are the costs and benefits of using the PHET simulation vs. real materials?

Q#3: Imagine we really were at Nido (miss that place!) doing this lab. Let's say we found some old batteries in a drawer with some uninsulated copper wire, some ceramic resistors and tried this lab for real. Imagine that we built a few circuits and took 5 measurements and then reviewed for a test. One team left their circuit hooked together during review time, and when they returned to the set up, and touched the copper connecting wires, they were quite hot to the touch. Let's say the group took 5 more sets of measurements using the heated circuit. How would the values for (r) and (ε) change from a cool circuit to a hot one, Is this a random or systematic error? Briefly explain.

LAB DUE: Please submit to Turnitin.com before the end of class today. It should be short! :)