RC_Circuits

RC Circuits Lab Q1
Open the Logger Pro program RC_RL_Circuits via the Logger Launcher icon on your desktop.

RC Circuits Lab Part1
Part 1: Measuring Voltage and Current in an RC Circuit

1. Hook up to measure voltage across and current through a single resistor driven by the battery (the first circuit pictured below).
2. Quickly measure the resistance of the resistors (how can you do that?)
3. Create a circuit with the resistor and the capacitor in series with the battery (the second circuit pictured below).
4. Connect the voltage sensor (channel 2) across the capacitor.
5. Record V, the voltage across the capacitor, and I, the current sourced by the battery. Click the Collect button or press the space bar. During this time the battery will switch between putting out 4 Volt and 0 Volts.
RC Circuits Lab Q2
Starting from a point in time where the voltage across the battery ($V_B$), the voltage across the capacitor ($V_C$), as well as the current ($I$) are all zero, what happens when the battery is "turned on" (switch closed)?

a) $I$ jumps up then decays as $V_C$ rises  
b) $V_C$ jumps up then decays as $I$ rises  
c) $I$ & $V_C$ both jump up then decay  
d) $I$ & $V_C$ both gradually rise  
e) I don’t know

**RLC Circuits Lab Q1**
What is the resistance of the resistor and how did you measure it?

**RC Circuits Lab Q3**
Examine the exponential decay part of the *voltage* curve. Right click on the graph and select "Move to Back." A logarithmic plot of voltage vs. time should appear. Fit a straight line to the data by highlighting a desired region and clicking the linear fit button.

What did you get for the time constant of the circuit (include units)? [Hint: it's related to the slope].

**RC Circuits Lab Q6**
Using this time constant, what is the capacitance of the capacitor?
**RLC Circuits Lab Q2**
What happens to the time constant if we put a second resistor in series with the capacitor?

**RLC Circuits Lab Q4**
If we change the order of elements in the circuit (e.g., put the capacitor before the resistor or switch the voltage leads), how is the time constant affected?

**RLC Circuits Lab Q3**
What happens to the time constant if we put another capacitor in parallel with the first capacitor?

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**RL Circuits Lab Part 3**

**Part 2: Measure Resistance and Inductance in an RL Circuit With a Core**

1. Assemble the RL circuit as shown below.
2. Connect cables from the output of the Lab Pro device to either side of the coil.
3. Make sure that the core is inserted into the coil.
4. Record the current through and voltage across the battery (i.e. Potential 2).
   - Click the Collect button or press the space bar.
5. To view a smaller temporal window, highlight the area that you wish to view and click the zoom button.
**RL Circuits Lab Q1**
What is the maximum current during the cycle? What is the EMF generated by the inductor at the time this current is reached?

**RL Circuits Lab Q2**
What is the time constant $\tau$ of the circuit?

As before, examine the exponential decay part of the *voltage* curve. Right click on the graph and select "Move to Back." A logarithmic plot of voltage vs. time should appear. Fit a straight line to the data by highlighting a desired region and clicking the linear fit button.
**RL Circuits Lab Q3**
What are the resistance $r$ and inductance $L$ of the coil? Explain how you got your answers.

**RL Circuits Lab Part 4**
**Part 3: Measure Resistance and Inductance in an RL Circuit Without a Core**

1. Remove the core from the center of the coil.
2. Record the current through and voltage across the battery for a fraction of a second. Click the Collect button or press the space bar.

**RL Circuits Lab Q4**
Does the maximum current in the circuit change due to the removal of the core? If it does, try to explain as clearly as possible why this happens.

**RL Circuits Lab Q5**
Does the time constant $\tau$ of the circuit change due to the removal of the core? If it does, try to explain as clearly as possible why this happens.

**RLC Circuits Lab Q5**
**Part 4: Free Oscillations in an Undriven RLC Circuit With a Core**
1. Assemble the RLC circuit as shown below, placing the core in the inductor.
2. Record the current through and voltage across the battery for a fraction of a second. Click the Collect button or press the space bar.

**RLC Circuits Lab Q7**
Determine the period of oscillations by measuring the interval between widely spaced zeroes of the current and dividing by the number of periods within this interval. Count the periods carefully! What is the frequency?

**RLC Circuits Lab Q8**
The frequency of oscillation for an RLC circuit is $f_0 = (2\pi)^{-1}(LC)^{-1/2}$. Calculate this frequency. Is the frequency that you experimentally measured the same as,
larger than, or smaller than your theoretical result.

**RLC Circuits Lab Q8**
The total energy stored in both the capacitor and inductor is calculated in a column in your data table. Examine a plot of total energy vs. time by right clicking on your graphs and selecting "Move to Back" until the plot is viewable.

**RLC Circuits Lab Q9**
Describe in words the shape of the graph of total energy versus time. For example, does it fall smoothly, does it oscillate up and down, or some other shape? Briefly explain why it looks the way it does.

**RLC Circuits Lab Q11**
Speculate about how removing the core would change the relative energy stored in the inductor compared with the capacitor. Test hypothesis.