PHYS1120

Summer 2025

1. Goal(s)

- Measure the resistance of a resistor using an RC circuit.

2. Materials

- Breadboard
- Batteries
- Unknown resistor
- *Logger Pro* Voltmeter
- Scissors
- Wires
- Alligator Clips
- Known capacitor
- *Logger Pro* Interface
- Multimeter

3. Equation(s)

$$V(t) = \mathscr{E}\left[1 - e^{-t/\tau}\right] \text{ (charging)}$$
$$V(t) = \mathscr{E}e^{-t/\tau} \text{ (discharging)}$$
$$\tau = RC$$
$$R = \frac{-(t_1 - t_0)}{C \ln\left|1 - \frac{V_1}{V_2}\right|}, \text{ (charging, } V_2 > V_1, \, t_2 >> \tau)$$

4. Methods

1. Wire and RC circuit on the breadboard. Do not connect the batteries yet. Only connect the negative terminal of the battery to the breadboard and leave the positive end disconnected for now.

2. Connect the *Logger Pro* voltmeter in parallel with the capacitor. Optionally, you can also connect the multimeter in parallel as well.

3. Open the *Logger Pro* software on the computer. Set the data collection for 100 s.

4. Hit "Collect" and connect the positive terminal of the battery to the breadboard.

5. Once the collection is complete, record the time you connected the battery to the circuit as t_0 below.

6. Record the capacitance in the table below.

7. Pick a voltage and time during the "fast-charging period" (when the voltage is increasing rapidly near the beginning of the run, before the voltage flattens out) from the table and record them as t_1 and V_1.

8. Now pick a voltage near the end of the run ($t \sim 100$ s) and record this voltage as V_2 below.

9. Calculate the predicted RC resistance using the equation above.

10. Repeat this calculation for different choices of V_1 and t_1 and verify you calculate the same value.

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5. Results

t_0 _____

t_1 _____

C _____

V_1 _____

V_2 _____

$R =$ _____

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6. Conclusions Now measure the resistance with the multimeter.

R_{multi} ———

How does this value compare with the calculated resistance?