Charging/Discharging of a Capacitor Lab

Procedure

Briefly, but completely, describe the procedure for this lab – and include labeled sketches.

Data

Charging	
t	ΔV
⋮	

Discharging	
t	ΔV
⋮	

Battery ε	
Resistance	

Graphs

Make separate graphs of ΔV vs t for the charging and discharging data. Then plot the linear graph $\ln(\Delta V)$ vs t for the discharge data (only!). Draw the best fits line.

Questions

1) Draw separate circuit diagrams for the charging and discharging of the capacitor. Using Kirchhoff's loop law, **derive** the formulas for the charge $q(t)$ for both the charging and discharging of the capacitor, in terms of the variables t, ε, R, and C. Use the charge formulas to **derive** the formulas for $\Delta V(t)$ across the capacitor and $I(t)$ for the circuit, for both the charging and discharging of the capacitor.

2) Use the resistor and capacitor values to calculate the time constant for your circuit. Looking at your charging graph, what voltage is 63% of the fully charged capacitor voltage? At what time did your capacitor voltage reach this value? Clearly mark this value on your graph. How does that value compare to your time constant?

3) The discharging formula can be turned into this linear formula: $\ln\Delta V = -\frac{1}{RC}t + \ln\frac{Q}{C}$. Show how to derive this equation.

4) Find the equation of your best-fits line and use the slope to find your experimental time constant. Show your work.

5) Use the y-intercept to calculate the charge of the fully charged 1 F capacitor. What should it have been? Explain your answer, and how your experimental value compares to the theoretical value.

6) Using your value from #2 as the accepted value, find the percent error for your graphical experimental time constant from #4. Explain your results.

Error Analysis

Thoroughly explain what the main sources of error are for this lab, and how you would correct them.