Modern Physics
Fall 2020

Name _____
Block _____
Date _____

Capacitors Lab

We have been exploring the relationships among capacitance, voltage, charge, resistance, and time. In particular, using calculus, we developed equations for the voltage on a charging capacitor and the current in the circuit as a function of time. In this process, we discovered that there is a time scale parameter, "tau" or τ, that is equal to R*C.
Your task is to formalize this exploration.

You have already done some measurements of resistance, capacitance, and time. Your teachers are blessed with some more sophisticated equipment that allows us to do more detailed measurements. They have shared these data with you. The equations we developed in class were based on the assumption that the charging began at time t=0. When collecting data in LoggerPro, the data collection software (and its clock) begin running before the capacitor begins charging. To account for this, you will need to subtract a starting time t_0 from the time values in the experimental data. Thus your capacitor voltage equation will be:

$$V_{cap} = V_{bat}\left(1 - e^{-\frac{t-t_0}{\tau}}\right)$$

The raw data are in the accompanying files. Note the filenames. They are important.

Fit the data to functions of the same form as above.

You will adjust V_{bat}, the start of the charging time, t_0, and τ (tau), to get a good fit to the data. Verify the relationships you learned in class among R, C, and τ.

Some of the data files include current. Do these graphs of current vs. time agree well with teh mathematical model? Verify that the total amount of charge on the capacitor after charging makes sense.

Also include the data that you and your classmates collected. Graph those data and explain outliers.

As you adjust your parameters, try to estimate, even subjectively, an uncertainty on your fitted values, especially the values of τ. You might also want to consider the uncertainties in the R and C values embedded in the file names.