Department of Physics

Worksheet for Lab 3: Capacitors

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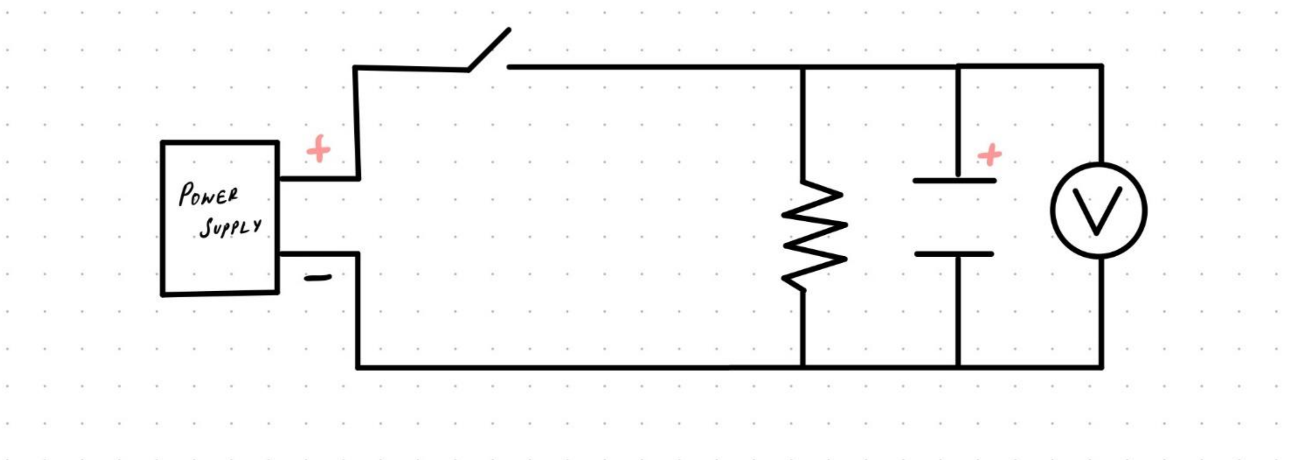
Section: | Date:

Use this sheet to enter and submit your answers to the questions asked in the gray boxes on the Lab Instructions document. When you have completed this worksheet, save this file as a .pdf and upload the pdf to the canvas assignment associated with this lab. If you have any trouble converting to a pdf, please ask you Lab Instructor or Lab Assistant.

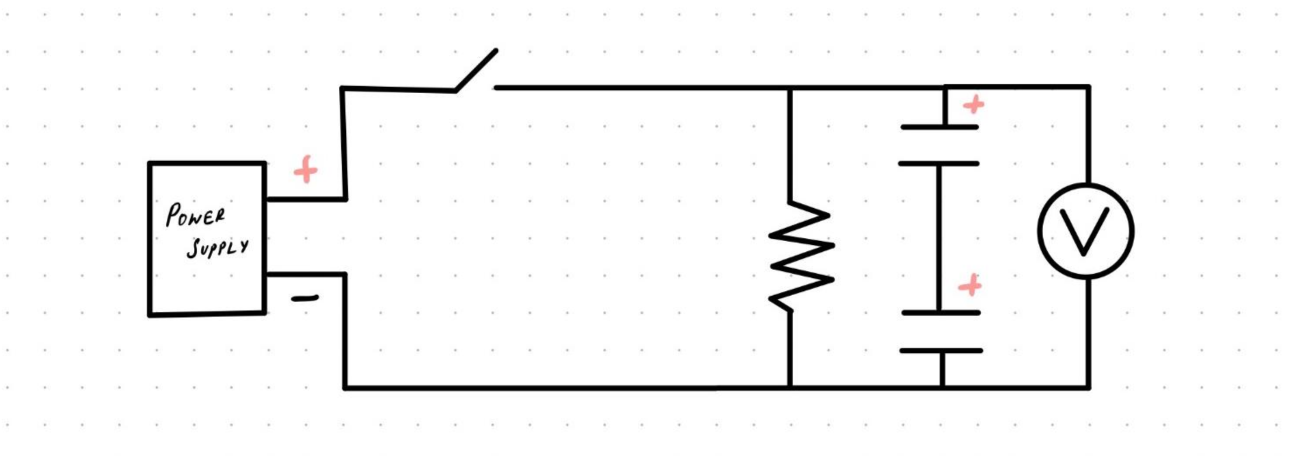
Remember to use complete sentences and that these text boxes will increase in size as you add more content.

Based on the data that you took today, write and answer the questions in the following sections. Remember that even though you will have the same data as your partner, the writing in these sections should be done individually.

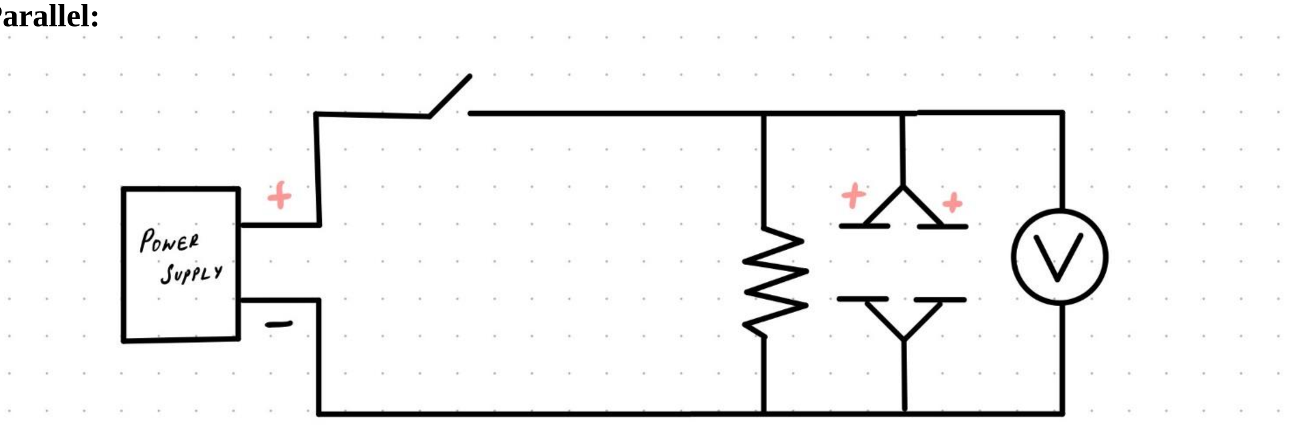
Circuit Diagram:



Series:



Parallel:



Tables and Raw Data

Create tables for your data.

Trial	LoggerPro C Values	Uncertainty (C)	Measured Capacitance	Uncertainty Measured	Theoretical Capacitance	Uncertainty
Capacitor 1	3.131	0.1781	14.887235328302025 µF	1.253747293019274 µF	10µF	1 µF
Capacitor 2	0.401	0.00202	113.13272872323990 µF	6.997323217983706 µF	100 µf	10µF
Series	4.02	0.05	12.9023472639238983 µF	1.3232237462873998 µF	9.09 µF	0.90909 µF
Parallel	0.373	0.0014	126.25648756294723 µF	8.382947932983748 µF	110 µF	11 µF

Experimental Method

1. The circuit is set up as per the circuit diagram drawn above
2. After giving it a power supply, adjust it to give out a power output of 5V.
3. When ready, we can start collecting the data from LoggerPro, and can be disconnected after 10 seconds once the data has been taken. As observing the graph, there should be a declining exponential graph depending different voltages across 5V and 3V.
4. This process is repeated with another capacitor, capacitors in parallel and capacitors in series.
5. Find the curve fit that best fits the data for each graph created from the data points in each experiment. Decide which natural exponent to use. A, B, and C will be produced by LoggerPro. Using A = Vo, B = any vertical offset in your circuit, and C = 1/RC. Use these variables to determine other things, such the capacitance of a capacitor.

Graph:

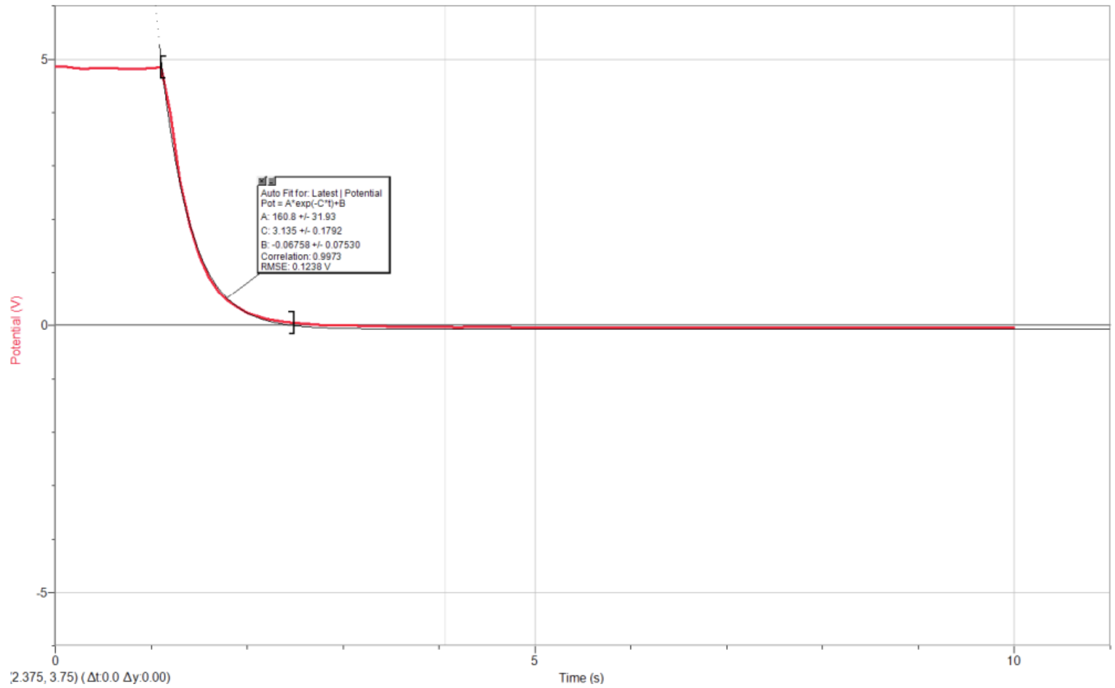


Figure: 1 Time and Voltage for Capacitor 1 (10 μF)

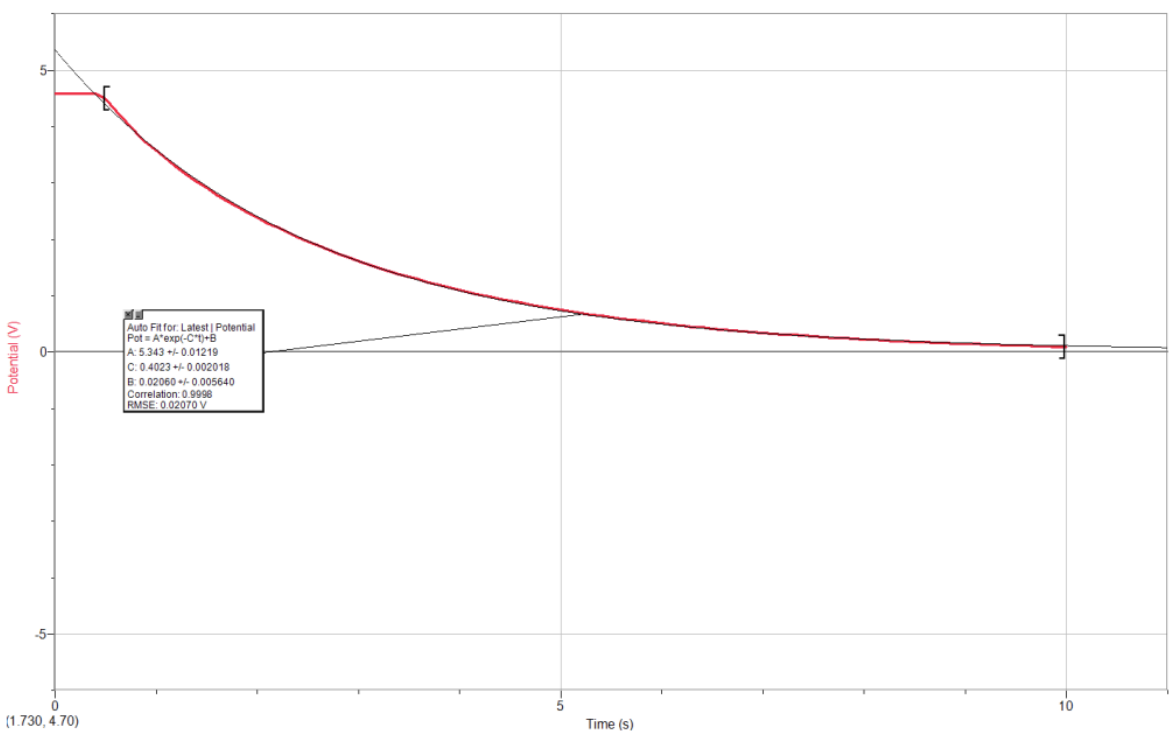


Figure: 2 Time and Voltage for Capacitor 1 (100 μF)

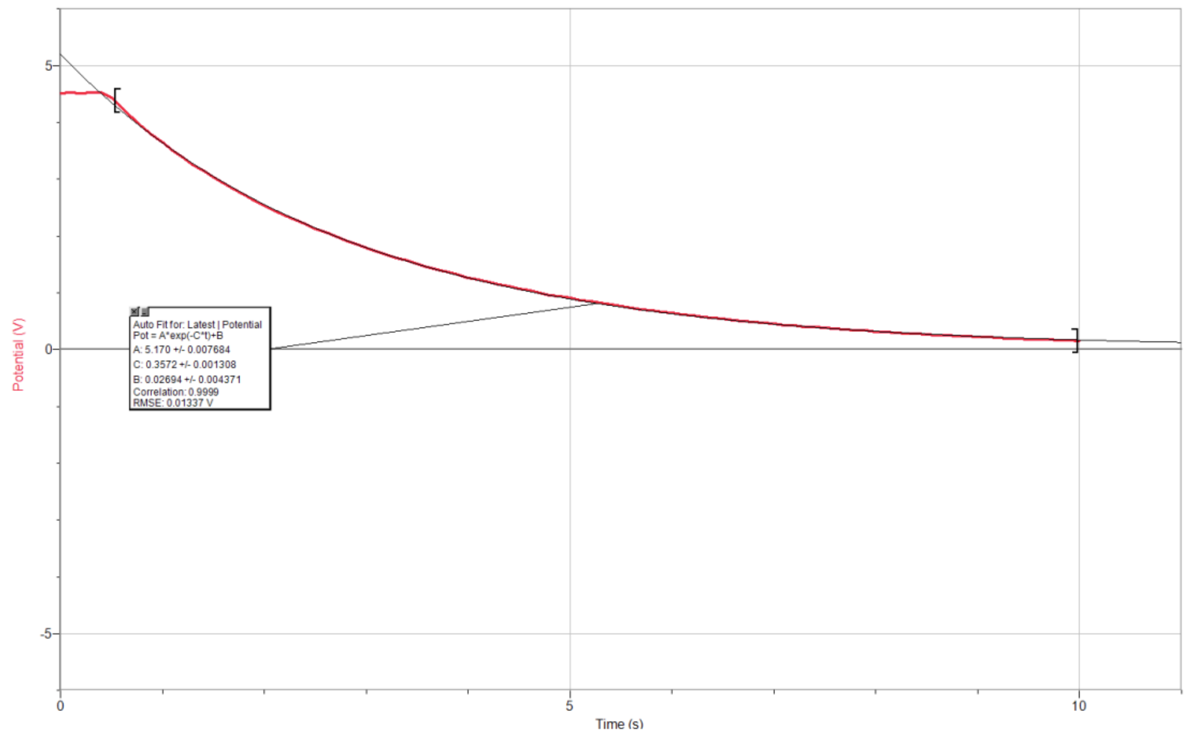


Figure: 3 Time and Voltage with 2 parallel capacitors (10 μF *0 100* μF*)*

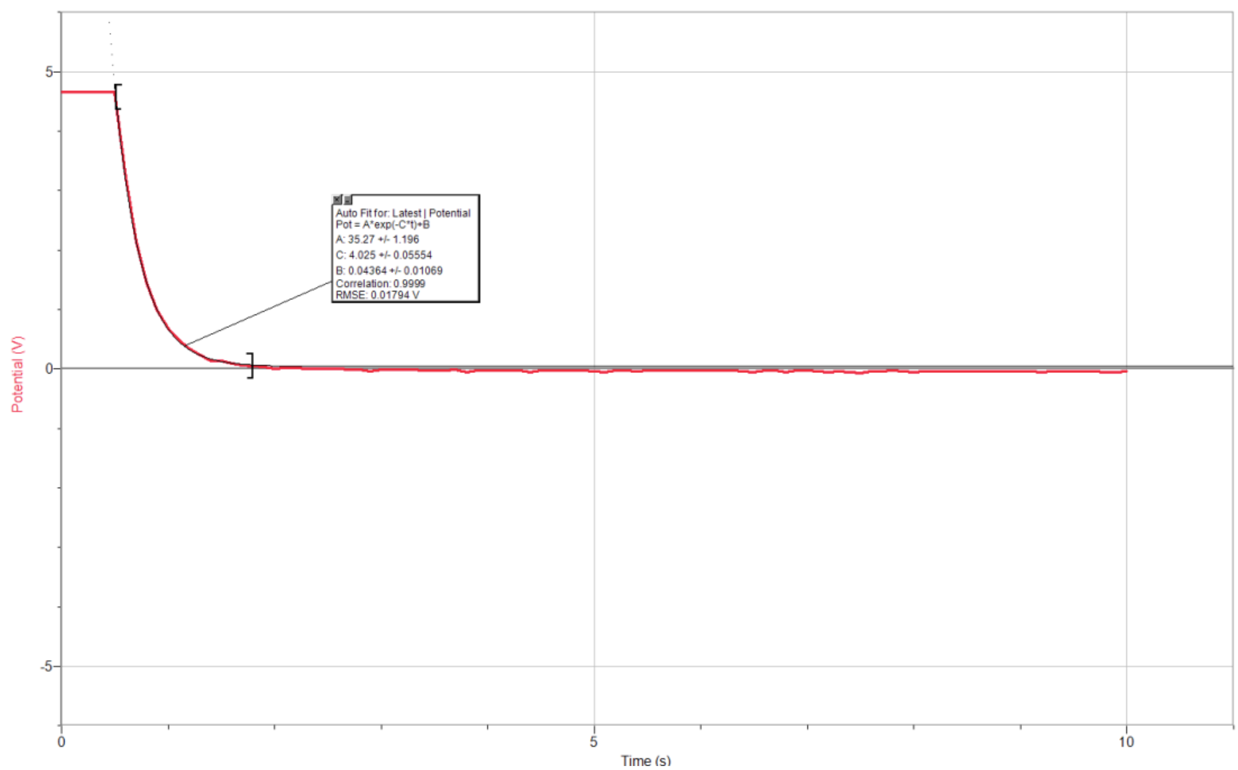


Figure: 3 Time and Voltage with 2 series capacitors (10 μF *0 100* μF*)*

Data Analysis

Show your work for the propagation of uncertainty for each value. Use the word equation editor or to show your work.

```
loggerPro_C1 = 3.135 # LoggerPro C for capacitor 1 (10µF) loggerPro_C2 = 0.4023 # LoggerPro C for capacitor 2(100µF) loggerPro_C1_uncertainty = 0.1792
# LoggerPro C uncertainty for capacitor 1 (10µF) = 0.005640 # LoggerPro C uncertainty for capacitor 2 (100µF)
10 # (pF)
loggerPro_C2_uncertainty theoretical C1 = theoretical_C2 = 100 # (pF)
#measured calculation
def measured_value (loggerPro_value):
resistor = 22000 # Ohms value for resistor
# Formula: LoggerPro C = 1/RC -> C = (1/Logger Pro C) / Value of resistor
# the unit for the equation above is mu Faraday
return ((1 / loggerPro_value) / resistor) * (10 ** 6)
def uncertainty_measured_value (loggerPro_value, loggerPro_uncertainty_value): resistor = 22000 # Ohms value for resistor
tolerance = 0.05 # tolerance for the resistor is 5%
return ((loggerPro_uncertainty_value / loggerPro_value) + (resistor tolerance) / resistor) measured_value(
loggerPro_value)
def capacitance_series (capl, cap2):
# the unit of input cap1 and cap2 is mu Faraday
# cap1 and cap2 is the measured value of the 2 capacitance not LoggerPro C return (cap1 * cap2) / (cap1 + cap2)
def capacitance_parallel (cap1, cap2):
# the unit of input cap1 and cap2 is mu Faraday
# cap1 and cap2 is the measured value of the 2 capacitance not LoggerPro C return (cap1 + cap2)
def capacitance_series_uncertainty (capl, cap2, capl uncertainty, cap2 uncertainty): # the unit of input capl and cap2 is mu Faraday
# capl and cap2 is the measured value of the 2 capacitance not LoggerPro C return ((cap2 ** 2) / ((cap1 + cap2) ** 2)) * capl_uncertainty + ( (cap1 ** 2) / ((cap1 + cap2) ** 2)) * cap2 uncertainty
def capacitance_parallel_uncertainty (capl_uncertainty, cap2_uncertainty):
# the unit of input cap1 and cap2 is mu Faraday
# cap1 and cap2 is the measured value of the 2 capacitance not LoggerPro return capl uncertainty + cap2_uncertainty
print(
*
f'Total capacitance 1: (measured_value (loggerPro_C1)} +/- {uncertainty_measured_value (loggerPro_C1, loggerPro_C1_uncertainty)} µF')
print(
f'Total capacitance 2: (measured_value (loggerPro_C2)} +/- {uncertainty_measured_value (loggerPro_C2, loggerPro_C2_uncertainty)} µF')
print(
f'Total capacitance (parallel): (capacitance_parallel (measured_value(loggerPro_C1), measured_value (logger Pro_C2))} +/-
    {capacitance_parallel_uncertainty (uncertainty_measured_value (loggerPro_C1, loggerPro_C1_uncertainty), uncertainty_measured_value (loggerPro_C2, loggerPro_C2_uncertainty))} µF')
print(
f'Total capacitance (series): (capacitance_series (measured_value (loggerPro_C1),
measured_value (loggerPro_C2))} +/-
    {capacitance_series_uncertainty (measured_value(loggerPro_C1), measured_value (loggerPro_C2), uncertainty_measured_value (loggerPro_C1, loggerPro_C1_uncertainty), uncertainty measured value (loggerPro C2, loggerPro C2 uncertainty))} µF')
```

Results

Total capacitance 1: 14.887235328302025 +/- 1.253747293019274 µF
Total capacitance 2: 113.13272872323990 +/- 6.997323217983706 µF
Total capacitance (series): 12.9023472639238983 +/- 1.3232237462873998 µF
Total capacitance (parallel): 126.25648756294723 +/- 8.382947932983748 µF

Conclusion

In the following experiment, Capacitor:1 – The theoretical capacitance was 10 µF, and the theoretical uncertainty was 1 µF. Whereas, the value we got for measured capacitance was 14.8 µF and uncertainty of 1.53 µF. Capacitor: 2 – The theoretical capacitance was 100 µF, and the theoretical uncertainty was 100 µF. On the contrary, the actual value we received was 113.18, and an uncertainty of 7.39 µF.

As it is subject to parallel and series; our theoretical capacitance was 9.09 µF, and the uncertainty was 9.09 µF for series. When it was measured, the values for the capacitance were 12.9 µF, and the uncertainty was 1.32 µF. As for parallel, our theoretical capacitance was 110 µF, and the uncertainty was 11 µF and the values we got when we measured was 126.2 µF, and the uncertainty was 8.38 µF.

In comparing the theoretical data and the measured data received, there were the difference in values in the following experiment. The experiment could have been improved by finding the best fit line for the graph, which would decrease the number of errors and given us a value closer to the theoretical values.