

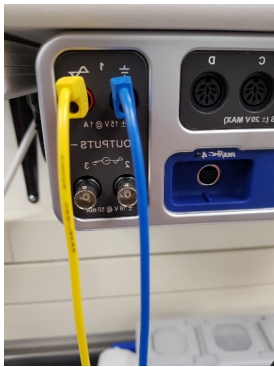
Physics 1E03: Lab 3

CAPACITORS AND THE RC CIRCUIT

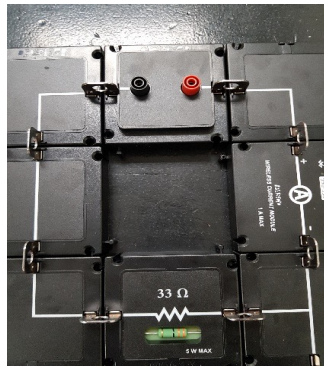
Lab Objectives

- Learn the basic properties of a capacitor experimentally and theoretically
- Analyze circuits which have current/voltage changing in time
- Understand the meaning of a time constant and how to find it for half an initial voltage
- Discharge a capacitor in parallel to a resistor and find the cumulated charge through integration
- Charge a capacitor through a resistor in a series circuit and experimentally analyze the results

Equipment



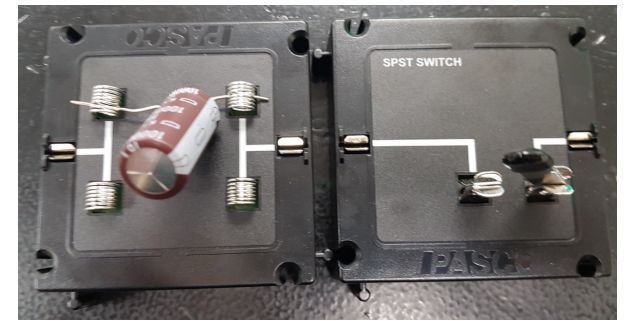
PASCO Capstone
Software



Circuit Building
Blocks



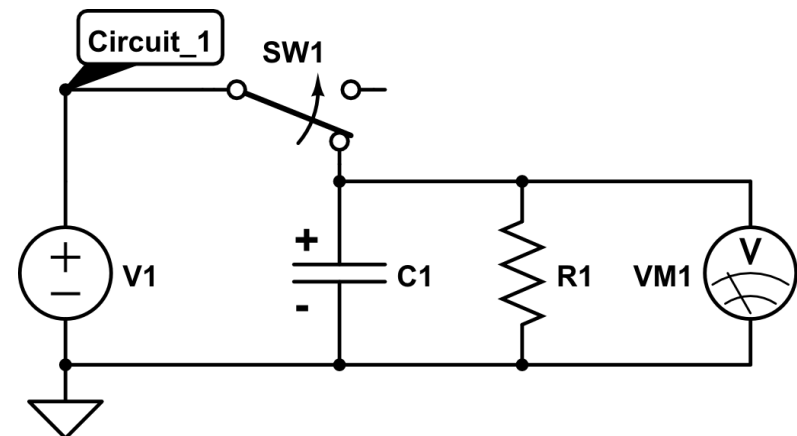
Digital Voltmeter & Ammeter



Capacitor & Switch

Part 1: Discharging the Capacitor

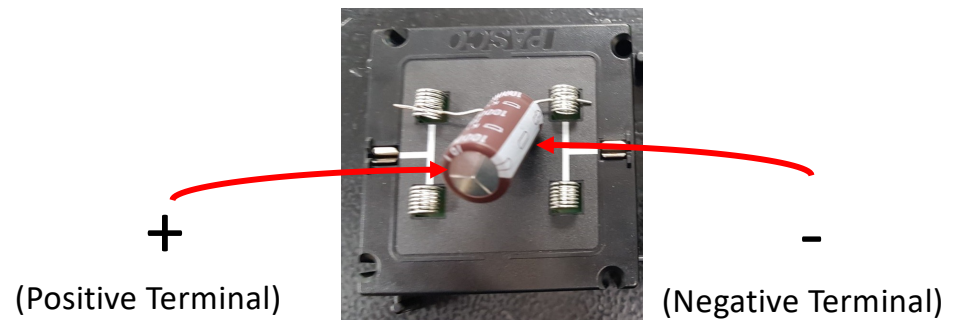
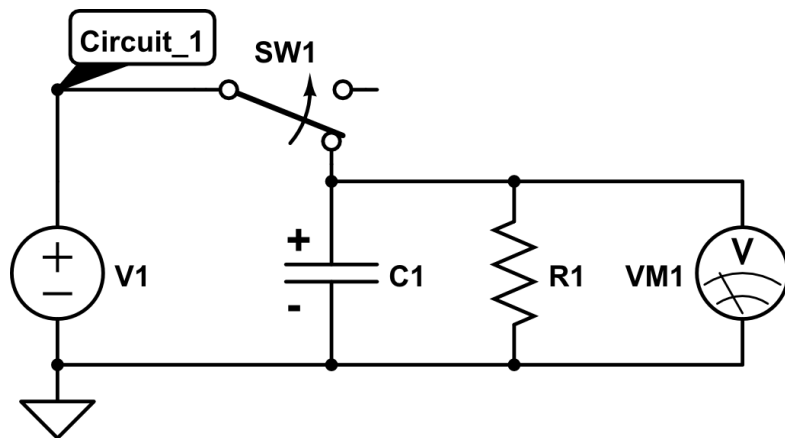
- Goal is to measure the time constant and capacitance of Circuit_1
- Start by building Circuit_1 using the building blocks and set up the power supply through the PASCO software



Part 1: Discharging the Capacitor

****IMPORTANT****

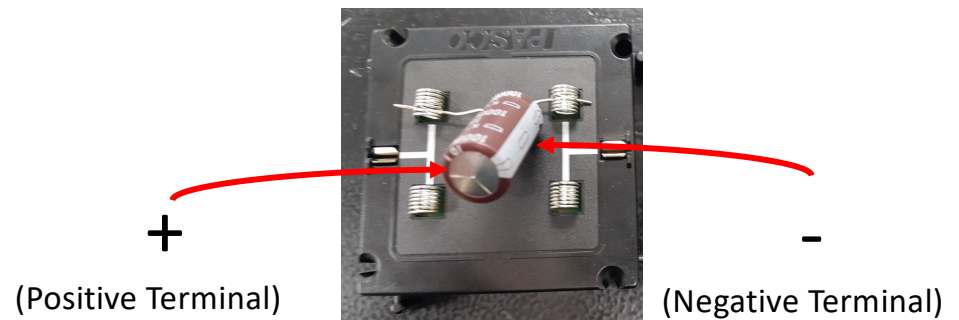
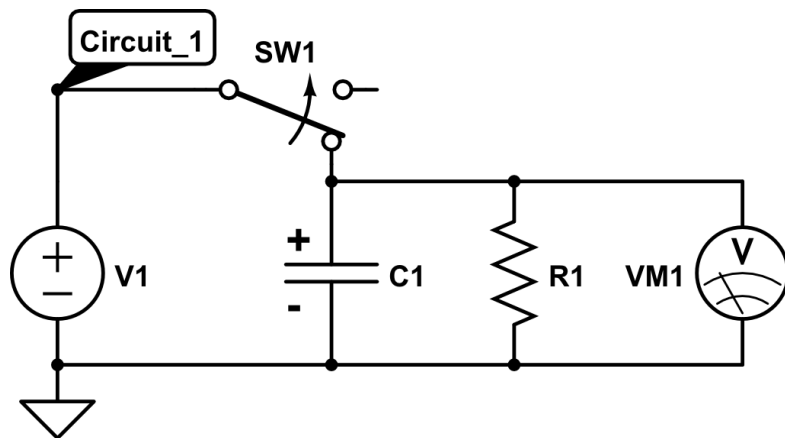
Make sure the capacitor's polarity is correctly orientated as shown in Circuit_1 (the white band indicates the negative side)



Part 1: Discharging the Capacitor

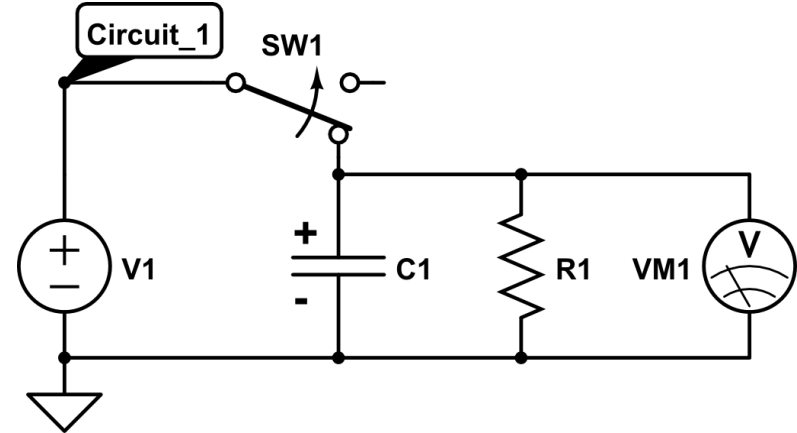
****IMPORTANT****

**Circuit_1 MUST be checked by a TA before continuing the lab.
Failing to do this will significantly affect the data you collect!**



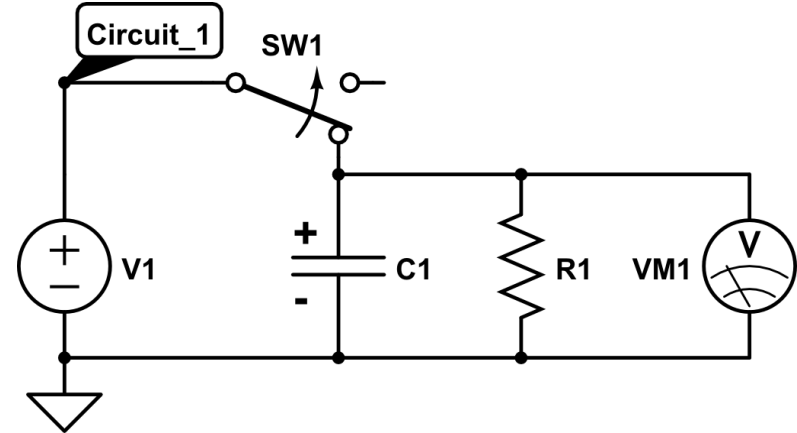
Part 1: Discharging the Capacitor

- After building Circuit_1 for $R1=1000\Omega$, set the power supply to 8V and use PASCO to measure the voltage
 - Save this run
- Repeat this two more times, using 6V and 4V as the power supply voltage
 - You **do not** need to save these, or any other future runs
- Record all values in your lab report



Part 1: Discharging the Capacitor

- Repeat the previous steps two more times
 - In the first rerun, set $R1=5000\Omega$
 - In the second rerun, set $R1=10000\Omega$
- Record all data in your report
 - Calculate the average value for the time constant you measured, as well as its standard deviation
 - Hint: Excel has a built-in function to do this for you, using AVERAGE and STDEV



Part 1: Discharging the Capacitor

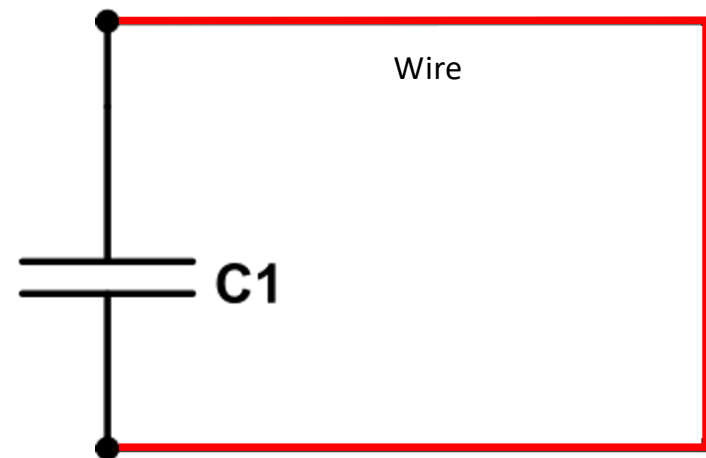
- Now we want to find the value of the capacitor in our circuit
- Using the data saved from the first run, plot a $\ln(V(t))$ vs. time graph over the appropriate range in time
- From the line of best fit, find what the capacitance should be
 - Hint: The voltage equation for a discharging capacitor in an RC circuit is

$$V(t) = V(0)e^{-\frac{t}{RC}}$$

$$\text{Or, } \ln(V(t)) = \ln(V(0)) - \frac{t}{RC}$$

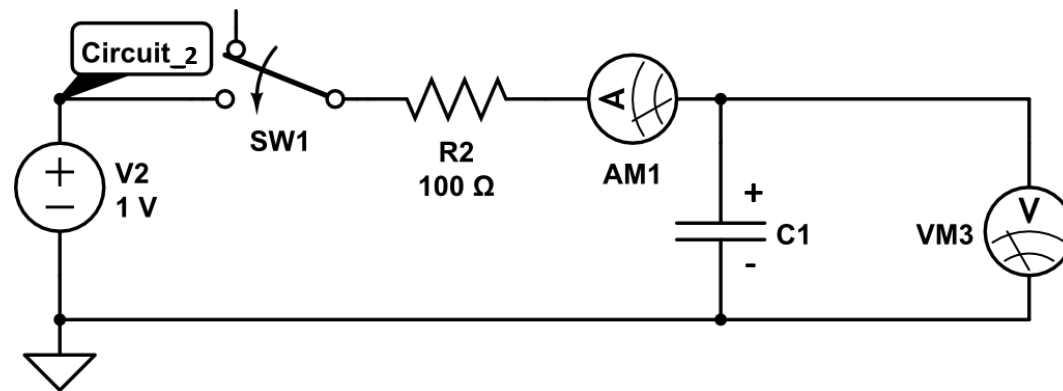
Part 2: Charging through a Resistor

- In this part, we will try to find the capacitance after charging it
- **Before** building the next circuit, we first have to discharge the capacitor
 - To do this, take a cable or wire with small resistance and hold its two ends to the two ends of the capacitor for a few seconds to discharge. This will discharge the capacitor at a relatively fast rate.



Part 2: Charging through a Resistor

- After building Circuit_2 and setting up the power supply, use the PASCO software to record a voltage vs. time and current vs. time plot
- Use your results to calculate the charge on the capacitor, and eventually the capacitance
 - Record these values in your report and include a picture of the voltage and current plots



Saving and submitting the report

The screenshot shows a Windows desktop with icons for Recycle Bin, Microsoft Edge, PASCO Capstone, 1E General, and E4 Demo. A red circle highlights a shortcut icon on the desktop labeled "St 16 - Shortcut (2)".

The File Explorer window is open to the path: Network > serv116 > Work1DE > St 16. The left sidebar shows the network location "serv116" selected. The main pane displays a list of folders and files:

Name	Date modified	Type	Size
Lab 1	2024-01-15 10:43 AM	File folder	
Lab 2	2024-01-15 10:41 AM	File folder	
Lab 3	2024-01-15 10:41 AM	File folder	
Lab 4	2024-01-15 10:41 AM	File folder	
1E03Lab_submission_process	2022-01-07 9:12 AM	Microsoft Edge P...	52 KB
Engineer_Reference_Material	2022-01-07 9:10 AM	Microsoft Edge P...	705 KB

A red box highlights the "Lab 3" folder in the list.

Below the file list, a red box contains the following instructions:

1. Save your MS Word report file the following name: "**L#-St#-lastname1-lastname2**".
 - a. The number signs indicate the lab section number and the current station number.
 - b. Lastname1 and lastname2 are the last names of both lab partners.
 - c. This will make sure the file is easy to track in case something happens.
2. Save your report "**L#-St#-lastname1-lastname2**" as a PDF.
3. Assuming wifi is active and enabled, go to www.crowdmark.com and follow the given steps:
 - a. Click on "Sign in" in the top right corner.
 - b. Select the school "McMaster University"
 - c. Select "Sign in with Avenue to Learn".
 - d. Note: only one student will need to submit on behalf of both students.
4. Once you selected to sign in through avenue, log into avenue to learn with your student Mac Id and password.
5. Repeat step 2 and go to the course "Physics 1E03: Introductory Mechanics".
6. Find your assessment which is labeled with your lab number (L#) and the current lab (Lab#).
7. Submit the pdf of your lab report.

Good Luck!