TechLab: Power in the Plates

an investigation of energy storage in capacitors

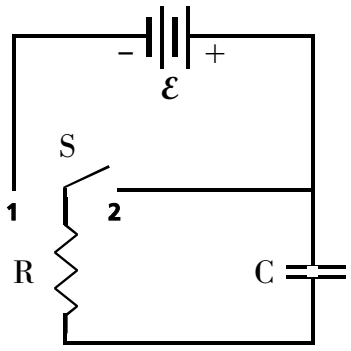
PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Purpose •

In this activity, you will investigate the energy associated with a capacitor as it charges and discharges in a resistor-capacitor (*RC*) circuit.

• Apparatus •

___ 1.0 F capacitor
___ mini bulb in socket [6.3 V]
___ 2 C- or D-cell batteries
___ 3 battery connectors (optional)
___ single throw double pole switch
___ connecting wires
___ computer
___ data analysis software (DataStudio)
___ interface device (USB Link)
___ current/voltage sensor



• Set Up •

1. Turn on the computer and set it aside.

2. Connect the circuit shown. Note: the switch is in an open (up) position during circuit construction.

3. Connect the current/voltage sensor so that it measures the current through the capacitor and the voltage across the capacitor.

4. Connect the current/voltage sensor to the interface device.

5. Connect the interface device to the computer.

6. When the computer detects the sensor and asks what you would like to do, select DataStudio.

7. When DataStudio asks what you would like to do, select Open Activity: 2.07 Power in the Plates (in the Phyz TechLabs folder).

8. Make certain the capacitor is discharged by touching opposite ends of a wire to both terminals of the capacitor for a few seconds.

• Procedure •

1. Observe the charging of the capacitor while recording the current, voltage, and power.
   a. Click the on-screen "start" button to initiate data sampling.

   b. Close the switch to position 1 and wait for the capacitor to completely charge.

   c. Open the switch and click the on-screen "Stop" button to stop data sampling.

2. Determine the charge separated in the capacitor by evaluating the area bounded by the current vs. time plot. Click on the graph to make it active. Then select all data in the current vs. time plot, then use the Statistics Tool: Area.

3. Show calculations to determine the energy stored in the capacitor
   a. using the maximum potential attained by the capacitor (find it on the graph) and the value of the capacitor's capacitance (find it on the capacitor).

   b. using the capacitor's capacitance and the charge separated in the capacitor (area bounded by current plot).

   c. using the maximum potential attained by the capacitor and the charge separated in the capacitor.

   d. How do these results compare to each other? Which one do you think is most reliable and why?

4. Notice you also have access to a power vs. time plot. How can you use this plot to determine the energy added to the capacitor?
   a. Describe your method.

   b. Show the result. Verify that the units are, in fact, units of energy.

   c. How does this result compare to those shown above? This value should be considered the most reliable.

5. Print the graphs (including all statistical notes), one for each member of the group.

6. Save the experiment to the folder or directory designated by the instructor. Title it by period, group, and lab title (e. g. "3C Power in the Plates").

7. Create a second set of voltage, current, and power graphs. File > Open Activity > "2.07 Power in the Plates."

8. Before recording data, make sure the capacitor has a full charge. Then observe the discharging of the capacitor while recording the current, voltage, and power.
   a. Click the on-screen "start" button to initiate data sampling.

   b. Close the switch to position 2 and wait for the capacitor to completely discharge.

   c. Open the switch and click the on-screen "Stop" button to stop data sampling.

9. Determine the energy released by the capacitor while it discharged.
   a. Describe your method.

   b. Show the result.

   c. How does the energy released by the capacitor during discharge compare to the energy added while it was charging?

   d. Determine an "efficiency" (e) by dividing the energy released by the energy added.

• Challenge •

1. Generate a plot of charge vs. voltage for the process of charging a capacitor.

2. How can the capacitance of the capacitor and the quantity of energy stored by the capacitor be determined from such a plot?

3. Carry out this analysis and record your findings. Print the plot.