**RC circuits**

**Materials:**

digital multimeter

DC power supply

Pasco 750 interface, with voltage leads

Resistors: 10 kΩ and 27 kΩ

Capacitors: 470 μF and 1000 μF (“low leakage”)

4 dual banana connectors for resistors and capacitors

DPST knife switch with banana jack connectors (optional)

About six connecting wires

**Activity 1**

Build the following circuit. If you do not have an actual switch, then you can accomplish the same thing by plugging and unplugging wires as needed.

*Be sure to connect the “negative” end of the capacitor to the negative terminal of the power supply, or it may explode and hurt you. The negative terminal is marked with a black strip and “-”signs running down the side of the capacitor. Ask your instructor for help if you are not sure.*



b. When you move the switch to position “1” as shown (so that terminals 1 and 2 are connected), what happens to the voltage difference across the capacitor?

c. With the switch in position “1” as shown, what is happening to the charge stored on the capacitor?

d. Now move the switch to position “3”. What happens to the voltage difference and the charge Q on the capacitor?

**Activity 2**

Because the voltage is changing, it will be useful to use your computer to graph *vs.* time. Put the two red and black leads from the 750 interface box where your digital voltmeter is connected to your circuit. (You can keep the DMM plugged in too.)

To record voltage versus time data, go to *Start* → *Programs* → *PhysicsApplications* →*Datastudio.* Select the option *Create Experiment.* You will see an image of the 750 interface box. On this image, click on the channel A input. You will see a list of sensors. Scroll down to the *Voltage Sensor* and select by clicking *OK*. Finally open a graph display by double clicking on the *Graph* option (on the left).

a. Now take some data. Draw sketches below showing *vs.* time when the switch is moved into position “1” (charging) and position “3” (discharging).

b. Helpful hint: if you get tired of waiting forever for to rise and fall, you can briefly “short out” the resistor by connecting an additional wire across it, like this.

How does “shorting out” the resistor affect when the capacitor is charging? When the capacitor is discharging?

c. Start with the capacitor fully charged at about 10 volts. Then (with the resistor not shorted out) move the switch to position “3” to discharge the capacitor. How long does it take for to drop to 1/3 of its original level (that is, from 10 volts to about 3.3 volts)?

d. If you repeat part (c) with a resistance kΩ how do you expect your result to change? Make a prediction and then test it.

Prediction:

Measurement:

e. Go back to using the 27 kΩ resistor. Now, if you repeat part (c) with a capacitance of µF, how do you expect your result to change? Make a prediction and then test it.

Prediction:

Measurement:

f. The time it takes for to fall to about a third of its original value (actually to 1/ of its value, where ) is called the time constant, . Fill in the following table:

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 10 kΩ | 470 µF |  |
| 27 kΩ | 470 µF |  |
| 10 kΩ | 1000 µF |  |
| 27 kΩ | 1000 µF |  |

g. What is the relationship between , , and ?

h. Looking at your graphs, what is the functional form of *vs.* time for a discharging capacitor? Try moving your data to Excel and fitting it to test your hypothesis.