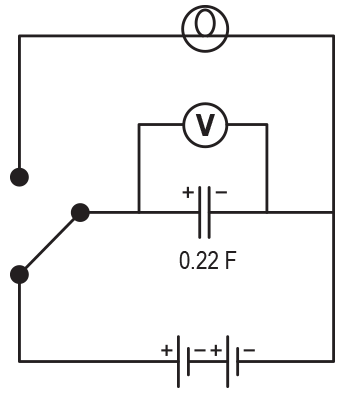
# **Investigation: Capacitors**

**Essential Question: How do capacitors work?**

In addition to the resistor, a standard component found in most electronic circuits is the capacitor. Capacitors are designed to store electric charge, which has many useful applications in circuits. In this investigation, you will explore how a capacitor stores charge and how that charge can vary based on the circuit design.

Part 1: Discharging a capacitor though an electrical device



1. Open the experiment file **Capacitors** and then connect the voltage sensor to your software.
2. Build the circuit shown in the diagram.
3. Begin recording data and close the switch toward the battery branch of the circuit to charge the capacitor. Observe the voltage.
4. Once the capacitor is charged, flip the switch to the branch containing the light bulb to discharge the capacitor. Observe the light bulb.
5. Replace bulb with a motor and repeat the experiment. Observe the motor as you discharge the capacitor.
6. Repeat the experiment using the 33 ohm and 100 ohm resistors.

Questions

1. How does the charging time compare to the discharging time? What can you account for the difference?

Answer: The charging time is much faster than the discharging time, due to there not being any significant resistance in the circuit when the capacitor is charging.

1. What happened to the light bulb when the capacitor was discharging?

Answer: The light bulb started bright and slowly dimmed out.

1. What was the voltage equal to when the bulb was no longer lit? If the light bulb is not lighting up when voltage is applied, where is the energy going?

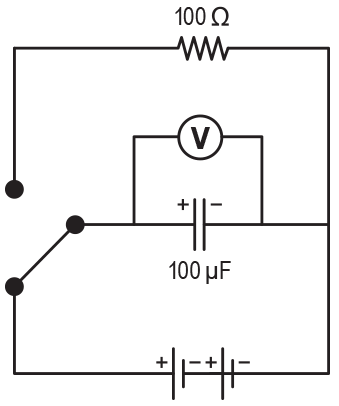
Answer: Around 0.4 volts. The energy applied is being dissipated as heat.

1. How does the voltage discharge rate for the 33 ohm resistor compare to the 100 ohm resistor? Why is the discharge time different for each resistor?

Answer: The discharge time is longer for the 100 ohm resistor, due to the 100 ohm resistor resisting current more than the 33 ohm resistor.

1. How does the voltage discharge for the motor compare to the bulb? Why is the discharge time different for the motor versus the bulb?

Answer: The voltage discharge for the motor does not follow the same exponential curve as the bulb and resistors. It initially drops off quickly when the motor is spinning, but then gradually discharges after the motor stops spinning. As this, it’s basically behaving like a standard resistor.

Part 2: Different Capacitors

1. Rebuild the circuit with a 100 ohm resistor and replace the 0.22 F capacitor with the spring clip module. Insert a 100 µF capacitor between the spring clips.
2. Repeat the experiment performed in Part 1 with the new circuit.
3. Remove the 100 µF capacitor and replace it with the 330 µF capacitor. Repeat the experiment.
4. Add a second 330 µF capacitor to the second set of spring clips so that the capacitors are in parallel. Repeat the experiment.

Questions

1. How does the discharge time for the 100 µF compare to the 330 µF capacitor? Why are the discharge times different? What does the capacitor rating tell us?

Answer: The discharge time is longer for the 330 µF capacitor. The capacitor is related to the amount of charge the capacitor can store. Thus, the larger the capacitor rating, the longer the discharge time.

1. How does the discharge time for the two capacitors in parallel compare to the discharge time for a single capacitor? Why?

Answer: Two capacitors in parallel take longer to discharge than a single capacitor. Wiring capacitors in parallel allows more charge to be stored.

1. Is connecting capacitors in parallel more similar to connecting two resistors in parallel or connecting two batteries in parallel? Explain.

Answer: It is more similar to connecting two batteries in parallel. Connecting two batteries in parallel provides more energy to a circuit. When connecting two reissitors in parallel, the overall resistance decreases, where in connecting two capacitors in parallel the capacitance increases.

1. What do you believe would happen to the discharge time if you connected two capacitors in series? Why?

Answer: Since connecting two capacitors in parallel causes the total capacitance to increase, connecting two capacitors in series would cause the total capacitance to decrease. When capacitors are connected in series, the voltage across each capacitor is half the total voltage, which means that the capacitor cannot store as much charge.