92 Brown Out

Purpose

To investigate charging and discharging a capacitor

Required Equipment/Supplies

CASTLE Kit (available from PASCO)
or
1 25,000 μF capacitor (20 volts nonpolar)
2 #14 lightbulbs (round) (no substitutions allowed!)
2 #48 lightbulbs (long) (no substitutions allowed!)
4 lightbulb sockets
1 packet of 12 alligator leads
1 D-cell battery holder and 3 D-cells

Discussion

When you switch on a flashlight, the maximum brightness of the bulb occurs immediately. If a capacitor is in the circuit, however, there is a noticeable delay before maximum brightness occurs. When the circuit contains a capacitor, the flow of charge through the circuit may take a noticeable time. How much time depends upon the resistance of the resistor and the charge capacity of the capacitor. In this activity, we will place a resistor (lightbulb) between the battery and the capacitor to be charged. By using bulbs of different resistances, the charging and discharging times are easily observed.

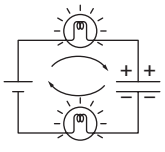
Procedure

Step 1: Connect a battery, two long bulbs, and a blue capacitor (25,000 μF) as shown in Figure A. Leave one wire (lead) to the battery disconnected. *Close* the circuit by connecting the lead to the battery and observe how long the bulb remains lit. You are *charging the capacitor.*

Assemble the circuit and charge the capacitor.

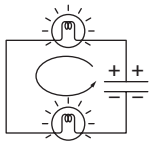
Step 2: Disconnect the leads from the battery and remove the battery from the circuit. Connect the two leads that were connected to the battery to each other as shown in Figure B. Observe the length of time the bulbs remain lit. This process is called *discharging the capacitor.*

Fig. A



Step 3: Replace the long (#48) bulbs in the circuit with round (#12) bulbs and charge the capacitor. Observe the length of time the bulbs remain lit. Remove the battery from the circuit as in Step 2 and discharge the capacitor through the round bulbs. Observe the time the bulbs remain lit. Which bulbs remain lit longer as the capacitor charges and discharges—long or round bulbs?

Fig. B



Activity

To account for the different times the bulbs are lit, we can make the following hypotheses:

- If bulbs affect the amount of charge that passes through them, bulbs that remain lit longer allow more charge to pass through them. The charge would be stored in the capacitor.
- If, however, bulbs affect the rate of charge flow rather than the amount of charge that flows, then bulbs that remain lit longer will increase the time during which charge flows through them.

Charge the capacitor.

Step 4: Charge the capacitor through two long bulbs. Now remove the long bulbs from their sockets and replace them with round bulbs, being careful not to accidentally discharge the capacitor.

1. Suppose the capacitor stores the same amount of charge no matter what type of bulbs are used during charging. Will discharging through round bulbs take more, less, or the same time as in Step 3—when the capacitor was *charged* through round bulbs?

2. If, instead, a longer charging time indicates more charge is stored in the capacitor than occurs with a shorter charging time, will discharging now through round bulbs take more, less, or the same time as it did in Step 4?

Discharge the capacitor.

Step 5: Remove the battery from the circuit and discharge the capacitor. Is the time the bulbs remain lit longer, shorter, or the same as in Step 3?

Analysis

3. (a) What is one use of a capacitor?

(b) Does the amount of charge stored in a capacitor depend on the type of bulbs through which it was charged? Explain.

4. Is it true that the type of bulb affects the rate charge flows through it? Why or why not?