16-2 Capacitance

Vocabulary **Capacitor:** A device that stores charge on conductors that are separated by an insulator.

Capacitance is a measure of the amount of charge stored on the conductors, for a given potential difference.

$$\textbf{capacitance} = \frac{\textbf{amount of charge}}{\textbf{potential difference}} \qquad \text{or} \qquad C = \frac{\Delta q}{V}$$

The SI unit for capacitance is the **farad (F),** which equals one **coulomb per volt (C/V).**

A capacitor may be used in a circuit by storing charge on two parallel plates and then periodically releasing it into the circuit, creating an intermittent flow of charge.

Solved Examples

Example 3: The first capacitor was invented by Pieter van Musschenbroek in 1745 when he and his assistant stored charge in a device called a Leyden jar. If 5×10^{-4} C of charge were stored in the jar over a potential difference of 10 000 V, what was the capacitance of the Leyden jar? (When van Musschenbroek touched the jar, he received such a large jolt that he exclaimed he would not try the experiment again for all the kingdom of France!)

Given: $\Delta q = 5 \times 10^{-4}$ C, $V = 10\,000$ V
Unknown: $C = ?$
Original equation: $C = \dfrac{\Delta q}{V}$

Solve: $C = \dfrac{\Delta q}{V} = \dfrac{5 \times 10^{-4}\ \text{C}}{10\,000\ \text{V}} = \mathbf{5 \times 10^{-8}\ F}$

Example 4: Lydia pushes the shutter button of her camera and the flash unit releases the 4.5×10^{-3} C of charge that was stored in a 500.-μF capacitor. What is the potential difference across the plates of the capacitor inside the flash?

Solution: The term μ (micro) means 10^{-6}, so a μF means 10^{-6} farad.

Given: $\Delta q = 4.5 \times 10^{-3}$ C, $C = 500. \times 10^{-6}$ F
Unknown: $V = ?$
Original equation: $C = \dfrac{\Delta q}{V}$

Solve: $V = \dfrac{\Delta q}{C} = \dfrac{4.5 \times 10^{-3}\ \text{C}}{500. \times 10^{-6}\ \text{F}} = \mathbf{9.0\ V}$

Practice Exercises

Exercise 6: The nervous system of the human body contains axons whose membranes act as small capacitors. A membrane is capable of storing 1.2×10^{-9} C of charge across a potential difference of 0.070 V before discharging nerve impulses through the body. What is the capacitance of one of these axon membranes?

Answer: _____

Exercise 7: During a lightning storm, the separation between the clouds and the earth acts as a giant capacitor with a capacitance of 2500 μF. If the transmitting tower of radio station KBOZ is hit by a bolt of lightning carrying 50. C of charge, what is the potential difference between the cloud and the tower?

Answer: _____

Exercise 8: Dr. Frankenstein brings his monster to life with electroshock treatment by discharging a 50.-μF capacitor through the monster's neck across a potential difference of 24 V. How much charge flows into the monster to make him come alive?

Answer: _____

Exercise 9: On Saturday nights, Greg likes to go the Frisco Disco, where he can dance under the strobe light. The strobe contains a 200-μF capacitor that stores charge over a 1000-V potential difference. If the strobe flashes 4 times each second, what is the current flow created by the strobe's capacitor?

Answer: _____

7. 2.0×10^4 V
9. 0.8 A