The Amazing Capacitor-Part 1 | What is a capacitor?

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The Amazing Capacitor - Part 1 [What is a capacitor?]
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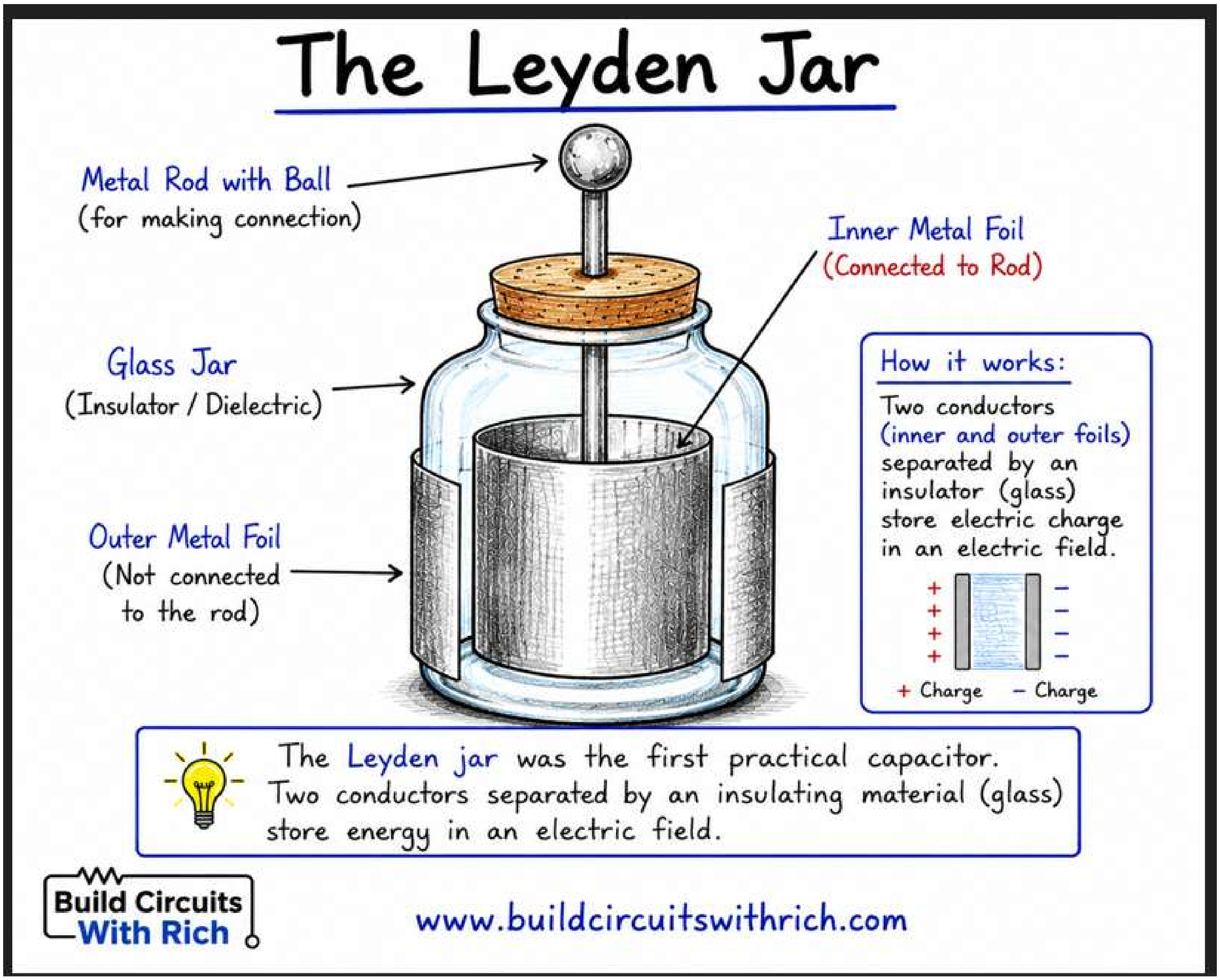


Michael Faraday
Born: September 22, 1791
Died: August 25, 1867 (age 75)
Nationality: English
Occupation: Physicist and chemist
Why is he important?
Michael Faraday made groundbreaking discoveries in electricity and magnetism. His work helped lay the foundation for electric motors, generators, transformers, and our understanding of electromagnetic fields.
Although he **did not invent the capacitor**, his research greatly advanced the understanding of capacitance and dielectrics.
The SI unit of capacitance—the farad (F)—is named in his honor.

Leyden Jar

Pieter van Musschenbroek

Born: March 14, 1692

Died: September 19, 1761 (age 69)

Nationality: Dutch

Occupation: Physicist, physician, mathematician, and professor

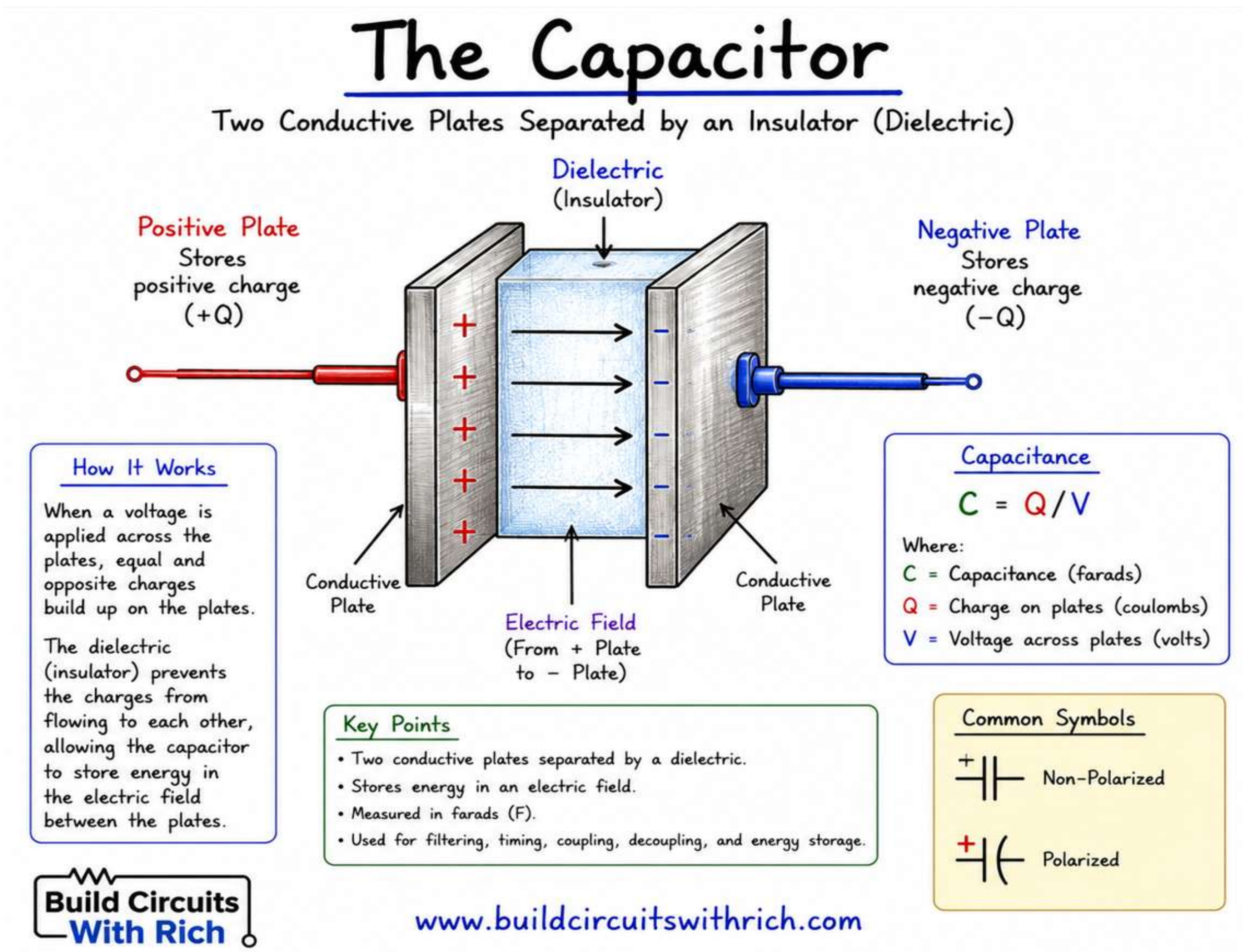
Why is he important?

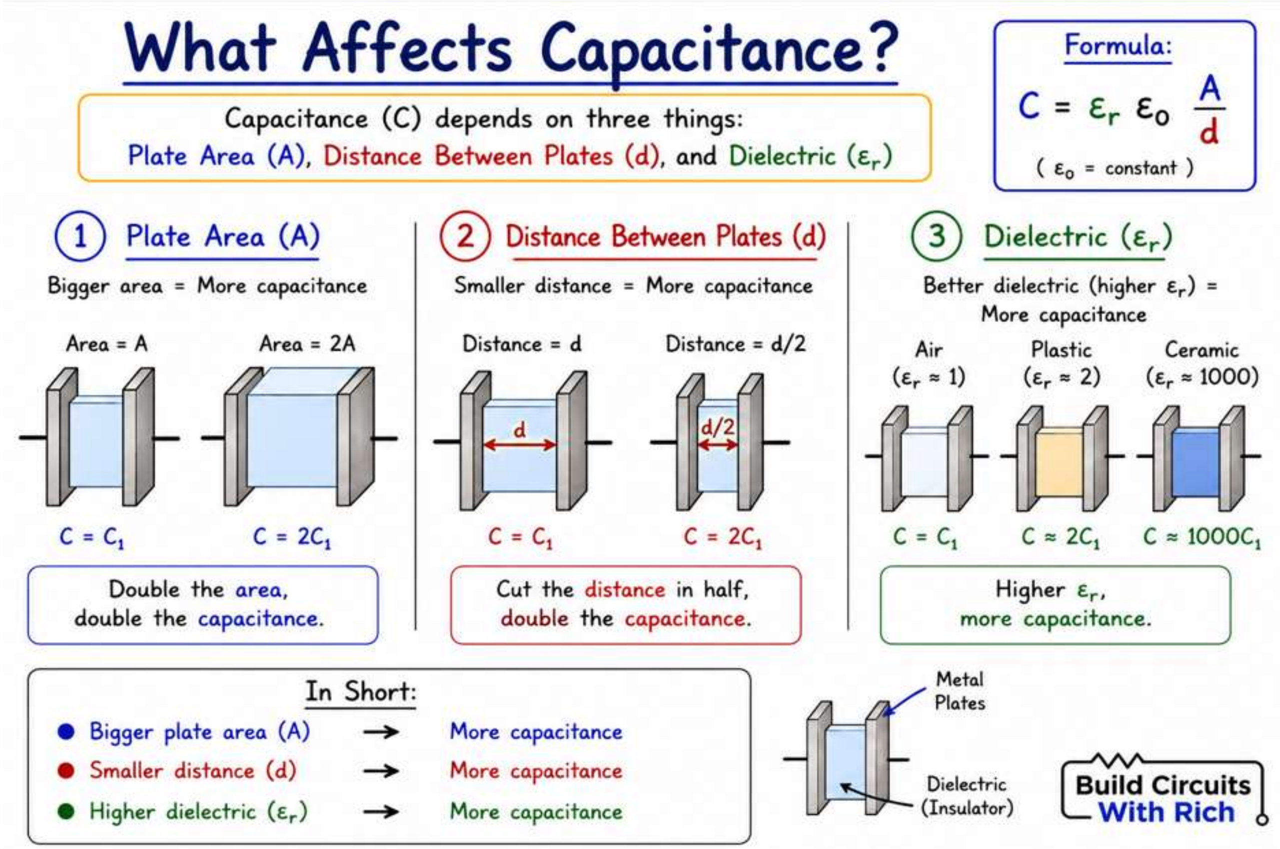
Pieter van Musschenbroek is credited with developing one of the first practical capacitors—the **Leyden Jar**—in 1746 while working at Leiden University in the Netherlands. His experiments showed that electrical charge could be stored and later released, laying the foundation for the modern capacitor. Around the same time, Ewald Georg von Kleist independently built a similar device.

1 micro farad = 1/1,000,000 F

1 nano farad=1/1,000,000,000 F

1 pico farad=1/1,000,000,000,000 F




What Affects Capacitance?
Capacitance (C) depends on three things:
Plate Area (A), Distance Between Plates (d), and Dielectric (ε_r)
Formula:
$C = \varepsilon_r \varepsilon_0 \frac{A}{d}$
(ε_0 = constant)
1 Plate Area (A)
Bigger area = More capacitance
Area = A
Area = 2A
$C = C_1$
$C = 2C_1$
Double the area, double the capacitance.
2 Distance Between Plates (d)
Smaller distance = More capacitance
Distance = d
Distance = d/2
d
d/2
$C = C_1$
$C = 2C_1$
Cut the distance in half, double the capacitance.
3 Dielectric (ε_r)
Better dielectric (higher ε_r) = More capacitance
Air ($\varepsilon_r \approx 1$)
Plastic ($\varepsilon_r \approx 2$)
Ceramic ($\varepsilon_r \approx 1000$)
$C = C_1$
$C \approx 2C_1$
$C \approx 1000C_1$
Higher ε_r, more capacitance.
In Short:
Bigger plate area (A) → More capacitance
Smaller distance (d) → More capacitance
Higher dielectric (ε_r) → More capacitance
Metal Plates
Dielectric (Insulator)
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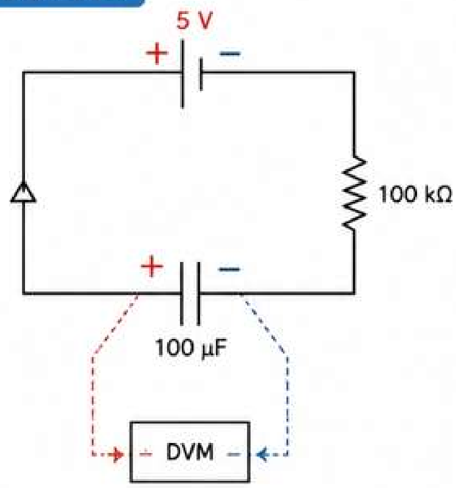
Lab

RC CIRCUIT: CAPACITOR CHARGING

THE CIRCUIT



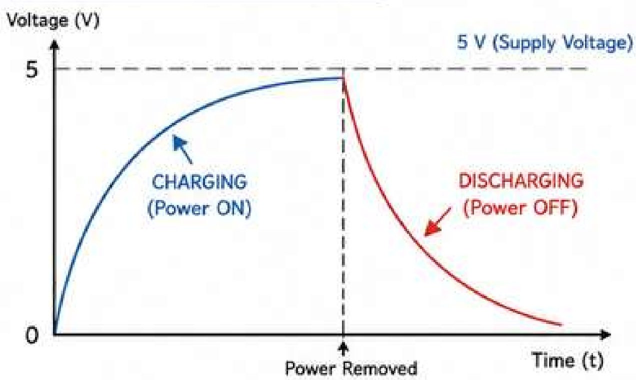
COMPONENTS

- 5 V DC Power Supply
- 100 kΩ Resistor
- 100 µF Capacitor
- Digital Voltmeter (DVM)

HOW IT WORKS

1. When power is applied, the capacitor charges through the 100 kΩ resistor.
2. The voltage across the capacitor (Vc) rises over time.
3. The DVM measures the voltage across the capacitor.
4. When power is removed, the capacitor can discharge through a resistor.

CAPACITOR VOLTAGE vs. TIME



KEY EQUATIONS

Time Constant (τ)

$$\tau = R \times C$$

Charging Equation

$$V_C(t) = V_S\left(1 - e^{-t/\tau}\right)$$

Discharging Equation

$$V_C(t) = V_0 - e^{-t/\tau}$$

R = Resistance (ohms)
C = Capacitance (farads)
V_S = Supply Voltage (volts)
V_0 = Initial Voltage on Capacitor

KEY TAKEAWAYS

- A capacitor stores energy in an electric field between its plates.
- The resistor limits current and controls how fast the capacitor charges or discharges.
- The time constant (τ = RC) determines how quickly the voltage changes.
- The capacitor does not charge instantly. It charges quickly at first, then slows down.
- Capacitors can remain charged after power is removed.

Practical Tip: Always discharge capacitors safely through a resistor before handling them. Never short a capacitor directly with a wire or screwdriver.