

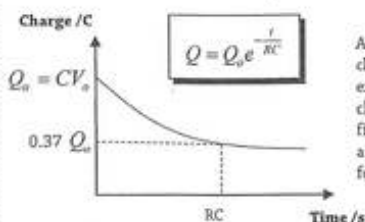
Capacitance

5

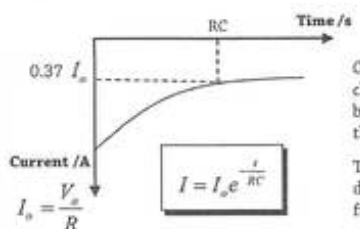
Capacitor charge and discharge

As a capacitor is charged or discharged, the charge stored by the capacitor, potential difference across the capacitor and current into / out of the capacitor follows exponential decay relationships.

Discharging a capacitor

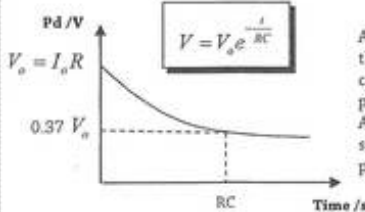


As a capacitor discharges, the charge stored decreases exponentially – as less and less charge is stored, the electric field in the capacitor decreases and charge is less likely to be forced out of the capacitor.



Current is the rate of flow of charge. Current is negative because charge is flowing out of the capacitor.

The modulus of current decreases as the flow of charge from the capacitor decreases.

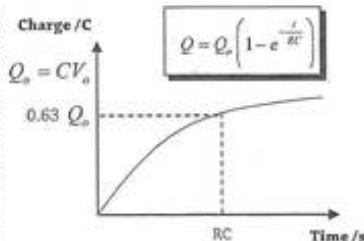


As charge leaves the capacitor, the electric field within the capacitor decreases, as does the potential across the capacitor. As the flow of charge decreases, so does the gradient of the potential with time.

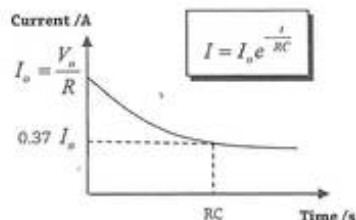
Time constant (RC)

- The time constant, RC , is the time taken for the initial charge, current or voltage to fall to e^{-1} (≈ 0.37) of its initial value
- The unit for time constant of the circuit is the second
- $T_{1/2}$ is the time taken for half the charge to discharge from the capacitor $T_{1/2} = 0.69RC$

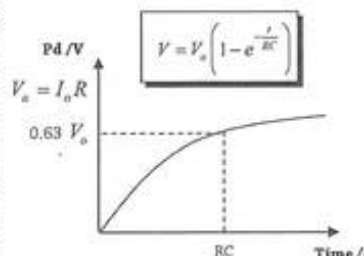
Charging a capacitor



As a capacitor charges, it becomes increasingly difficult to add more charge to the capacitor. The rate that charge is stored by the capacitor decreases and the gradient approaches Q_0 at the maximum amount of charge stored.

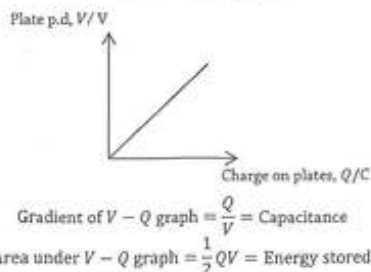


Current is the rate of flow of charge. Current is positive because charge is flowing into the capacitor. Current decreases as the flow of charge into the capacitor decreases.

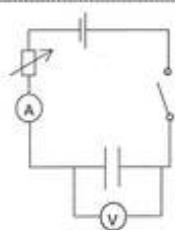


As charge enters the capacitor, the electric field within the capacitor increases, as does the potential across the capacitor. As the flow of charge decreases, so does the gradient of the potential with time.

Voltage-charge graph



Measuring capacitance



This circuit can be used to investigate capacitance.

When the switch is **closed** the capacitor **charges**, and when it is **open**, the capacitor **discharges** across the resistor.

By calculating the maximum potential across the capacitor and total charge held by the capacitor, we can find the capacitance of the capacitor and energy stored by the capacitor.

By attaching the voltmeter and ammeter to a **data logger** we can collect data for the graphs seen above.