



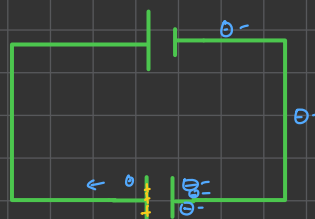
- Capacitor will start charging
- Capacitors store electrical charge
- Amount of charge stored is proportional to the p.d. (V) across the power supply

$$Q = CV \rightarrow C = \frac{Q}{V}$$

Definition: Capacitance is the amount of charge stored per unit of p.d.

Unit: Farad $1F = \frac{1C}{1V} (CV^{-1})$

Charging of a capacitor

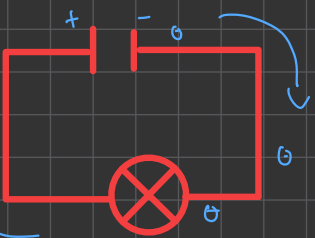


Electrons flow from the negative terminal of the cell to the negative plate of the capacitor

The excess electrons on the negative plate are going to repel electrons off the positive plate of the capacitor, which will move towards the positive terminal of the cell

Overall, the plates will acquire an equal and opposite charge

Discharging of a Capacitor



when a capacitor is connected to a circuit the excess electrons are going to flow from the negative plate to the positive plate

The charge of the capacitor decreases

Rearranging capacitor discharge equation

$$V = V_0 e^{-t/CR} \quad \text{rearrange for } t$$

$$\frac{V}{V_0} = e^{-t/CR}$$

$$\ln \frac{V}{V_0} = -t/CR$$

$$\ln \frac{V_0}{V} = t/CR \quad t = CR \ln \frac{V_0}{V}$$

Capacitors

Parallel

Adding: $C_T = C_1 + C_2$ $C_T = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{-1}$
* opposite of adding resistors

Voltage is the same across each parallel branch of the circuit

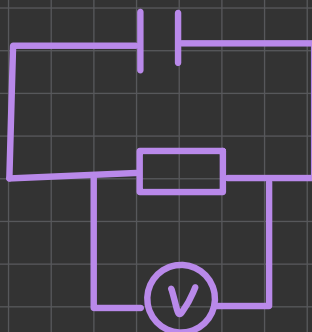
The charge is shared as current is shared

Series

Each capacitor will experience the same current so it will acquire the same charge

P.d. is shared by Kirchhoff's 2nd law

Capacitor discharging



$$V = V_0 e^{-t/CR}$$

$$Q = Q_0 e^{-t/CR}$$

$$I = I_0 e^{-t/CR}$$

- decreases exponentially

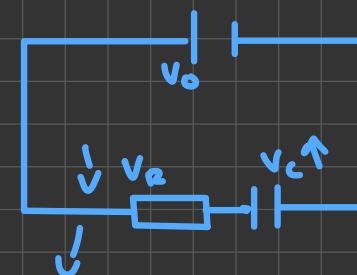
Constant property ratios of exponentials



In equal time intervals:

$$\frac{V_1}{V_0} = \frac{V_2}{V_1} = \frac{V_3}{V_2} = \dots$$

Charging of a capacitor



Initially the p.d. across the capacitor is 0

P.d. across capacitor increases
P.d. across resistor decreases

$$V_r = V_0 e^{-t/CR}$$

$$V_0 = V_r + V_c \rightarrow V_0 = V_0 e^{-t/CR} + V_c$$

$$\rightarrow V_c = V_0 - V_0 e^{-t/CR}$$

$$V_c = V_0 (1 - e^{-t/CR})$$

$$Q_c = Q_0 (1 - e^{-t/CR})$$

$I \downarrow$ as the capacitor is charging

$$I = I_0 e^{-t/CR}$$

Energy stored within a capacitor

$$W = \frac{1}{2} QV \quad w = \frac{1}{2} \frac{Q^2}{C}$$

$$W = \frac{1}{2} V^2 C$$

Area under V-Q graph is the energy stored within the capacitor

Capacitance