# AQA A-Level Physics

## 7.4 Capacitance

### Flashcards

# How is capacitance calculated?

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$$C = Q \setminus V$$

C = Capacitance (F)

Q = Charge in the plates (C )

V = potential difference across the plates (V)

What is the relative permittivity (a.k.a. dielectric constant)?

# What is the relative permittivity (a.k.a. dielectric constant)?

- The ratio of the charge stored with the dielectric between the plates to the charge stored when the dielectric is not present.
- $\varepsilon_r = Q / Q_0$
- The greater the relative permittivity, the greater the capacitance of the capacitor.

What does the area under the graph of charge against pd represent ?

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The energy stored by the capacitor.

# Describe the Q against t graph for the discharging of a capacitor through a resistor.

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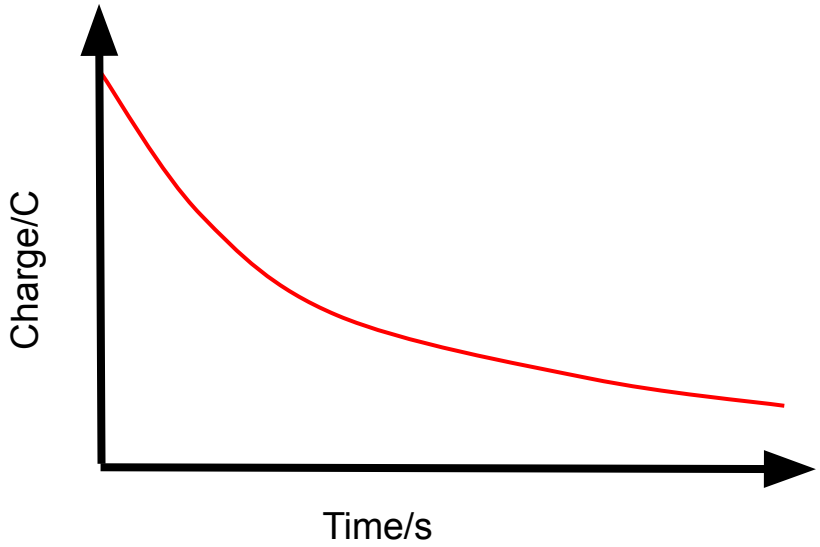

Describe the V against t graph for the discharging of a capacitor through a resistor.

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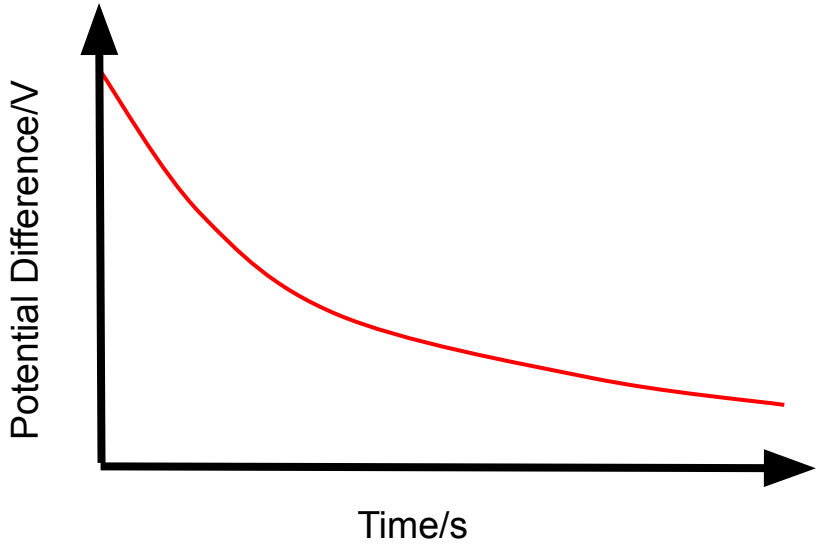

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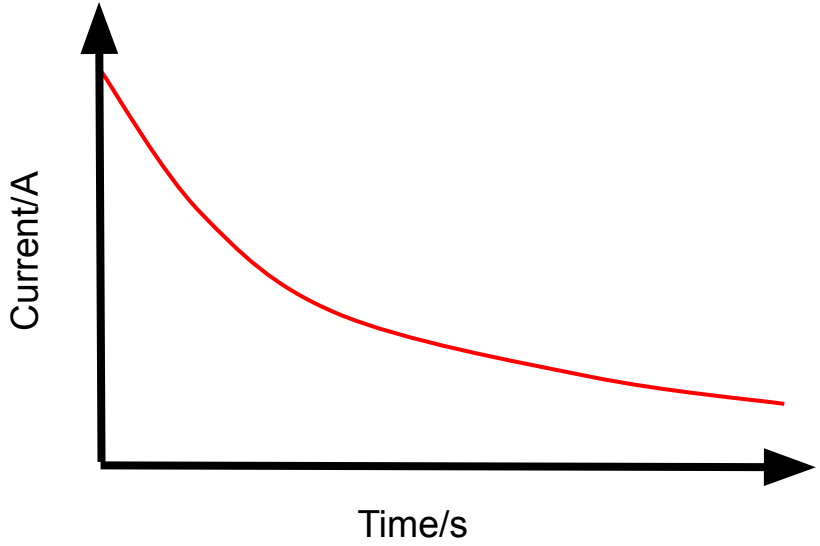
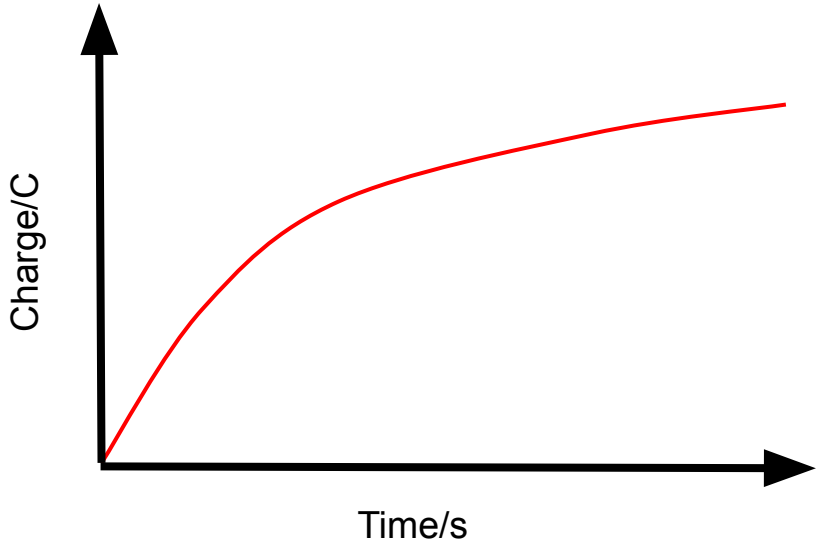


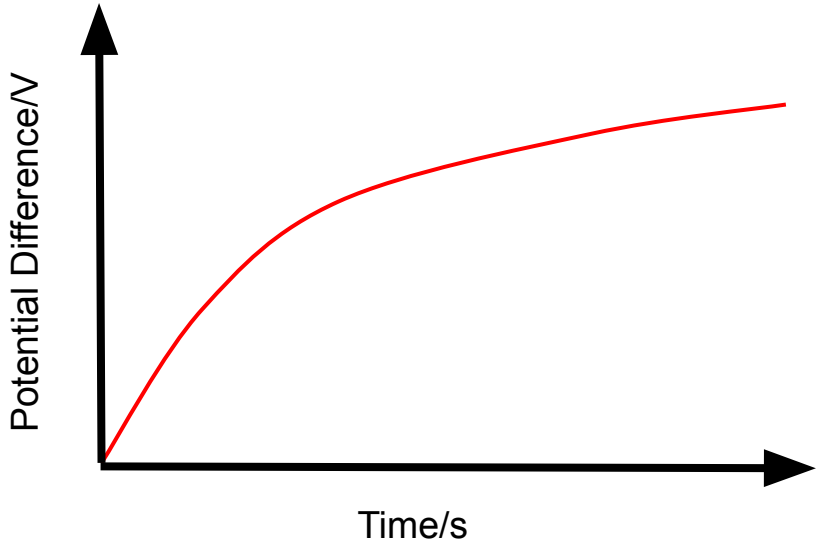
Describe the Q against t graph for the charging of a capacitor through a fixed resistor.

# Describe the Q against t graph for the charging of a capacitor through a resistor.



Describe the V against t graph for the charging of a capacitor through a fixed resistor.

# Describe the V against t graph for the charging of a capacitor through a resistor.



# What is the time constant?

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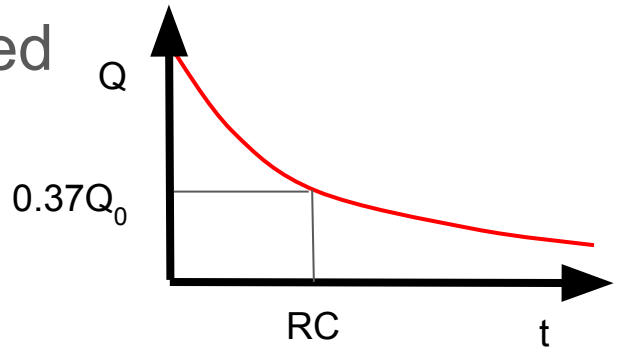
The time it takes for the charge in a capacitor falls to 37% of the initial value (explained in the following slide) given by RC (resistance x capacitance).

A capacitor is considered fully discharged after 5 time constants.



# How was 37% derived when using the time constant?

# How was 37% derived when using the time constant?

- Start with the formula $Q = Q_0 e^{-t/RC}$
- When $t = RC$ (after 1 time constant), the formula becomes $Q = Q_0 e^{-1}$
- $e^{-1} \approx 0.37$, which is where 37% came from.

# What is the half time of a capacitor?

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$$T½ = 0.69RC$$

# What equations do we require for charging a capacitor?

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Charging up a capacitor produces $Q = Q_0(1 - e^{-t/RC})$ & $V = V_0(1 - e^{-t/RC})$ where $V_0$ is the battery PD and $Q_0 = CV_0$.

# How does a capacitor charge up?

# How does a capacitor charge up?

1. Electrons move from negative to positive around the circuit.
2. The electrons are deposited on plate A, making it negatively charged.
3. Electrons travel from plate B to the positive terminal of the battery, giving the plate a positive charge.
4. Electrons build up on plate A and an equal amount of electrons are removed from plate B, creating a potential difference across the plates.
5. When the p.d across plates = source p.d., the capacitor is fully charged and current stops flowing.

Describe and explain in terms of the movement of electrons how the p.d across a capacitor changes, when it discharges across a resistor.

# Describe and explain in terms of the movement of electrons how the p.d across a capacitor changes, when it discharges across a resistor.

1. Electrons move in opposite direction than when the capacitor was charging up.
2. Charge on one plate A decreases as it loses electrons, and plate B gains electrons, neutralising them.
3. P.d. decreases exponentially across the plates.

State the 3 expressions for the energy stored by a capacitor.

State the 3 expressions for the energy stored by a capacitor.

$$E = \frac{1}{2}\left(\frac{Q^2}{C}\right) = \frac{1}{2}(QV) = \frac{1}{2}(CV^2)$$

# What 2 factors affect the time taken for a capacitor to charge or discharge?

# What 2 factors affect the time taken for a capacitor to charge or discharge?

- The capacitance of the capacitor, C. This affects the amount of charge that can be stored by the capacitors at any given potential difference across it.
- The resistance of the circuit, R. This affects the current in the circuit and how quickly it flows, hence how quickly the capacitor charges/discharges.