OCR (A) A-Level Physics

6.1 Capacitors

Flashcards

What is a capacitor?

What is a capacitor?

- A capacitor is an electrical component that stores charge on 2 separate metallic plates.
- An insulator, called a dielectric, is placed between the plates to prevent the charge from travelling across the gap.

What is capacitance?

What is capacitance?

The capacitance, C, is the charge stored, Q, per unit potential difference, V, across the two plates. Therefore we have $C = Q / V$. It is measured in Farads, F ($1F = 1CV^{-1}$).

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 is the equation for the total capacitance in series?

What is the equation for the total capacitance in series?

$$1/C_{total} = 1/C_1 + 1/C_2 + ...$$

What is the equation for the total capacitance in parallel?

What is the equation for the total capacitance in parallel?

$$C_{total} = C_1 + C_2 + \ldots$$

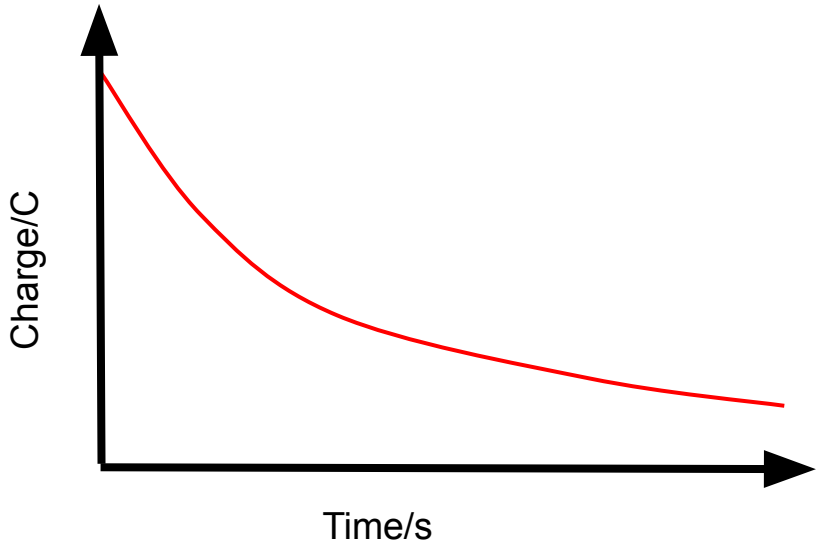
What does the area under the graph of charge against pd represent?

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

The energy stored by the capacitor.

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

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



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

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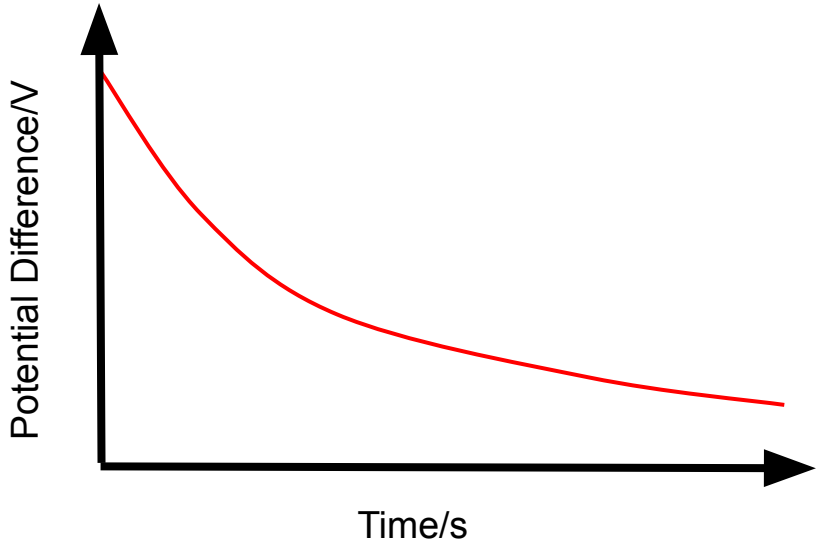

Describe the I against t graph for the discharging of a capacitor through a resistor.

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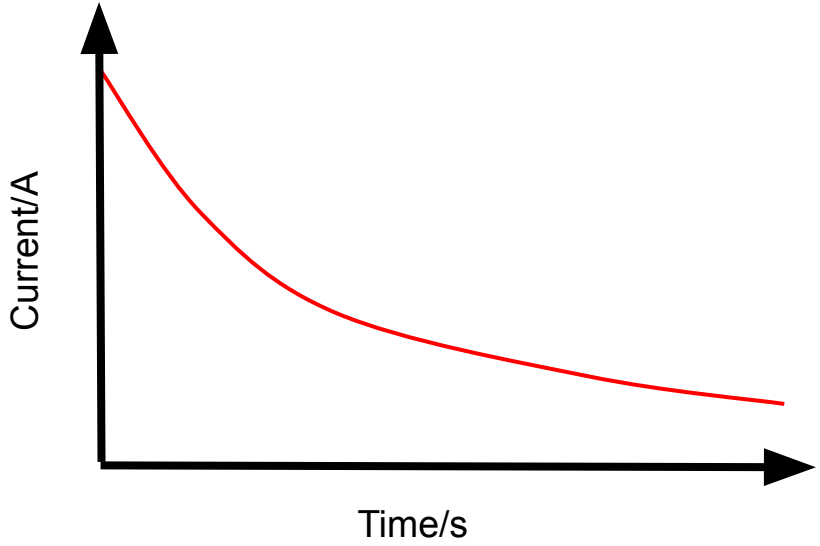
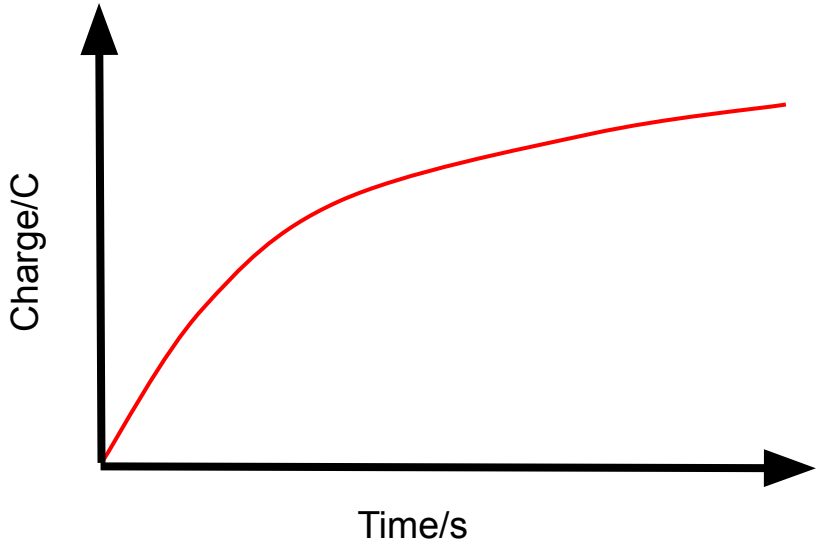


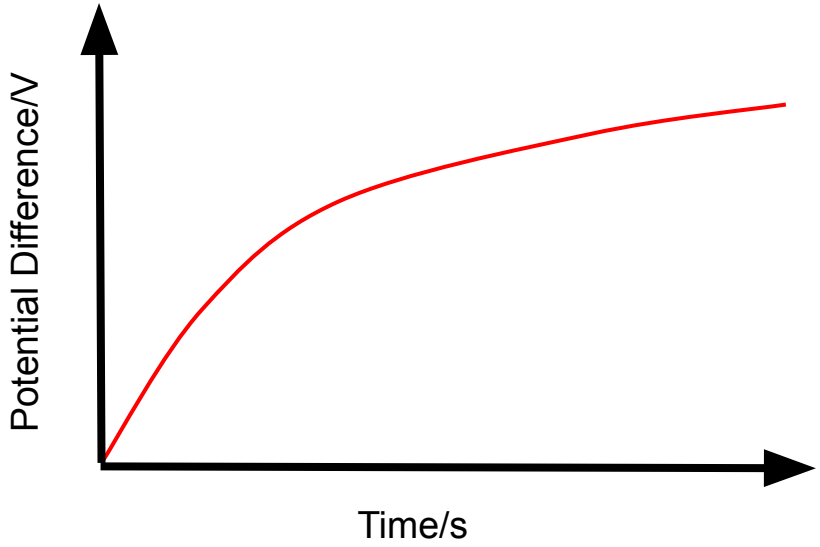
Describe the Q against t graph for the charging of a capacitor through a fixed resistor.

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.

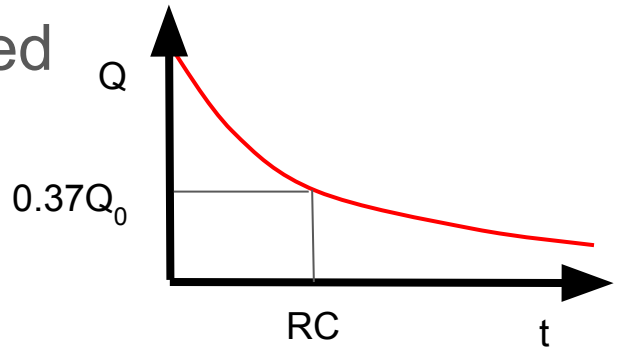


What is the time constant?

What is the time constant?

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 $Q = Q_0e^{-t/RC}$.
- When t = RC (after 1 time constant), the formula becomes $Q = Q_0e^{-1}$.
- $e^{-1} \approx 0.37$, which is where 37% came from.

What is the half time of a capacitor?

What is the half time of a capacitor?

$$T½ = 0.69RC$$

What equations do we require for charging a capacitor?

What equations do we require for charging a capacitor?

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 some uses of capacitors.

State some uses of capacitors.

- Flash photography
- Nuclear fusion
- Backup power supplies

Also:

- DC blocking
- Smoothing AC to DC
- Tuning (Resonating magnetic field)

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.