WJEC (Wales) Physics A-level

SP4.1a - Investigation of the Charging and Discharging of a Capacitor to Determine the Time Constant

Practical Flashcards

What must always be checked when using an electrolytic capacitor in a circuit?

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The electrolytic capacitor is a polarised component and so must be connected with the correct polarity in the circuit. If connected incorrectly, it can overheat and perhaps explode, thus becoming a safety hazard.

What equation is used to calculate the time constant of a resistor-capacitor circuit?

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Time Constant = Resistance x Capacitance

$\tau = RC$

What information does the time constant tell us?

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The time constant tells us how long it takes for the capacitor to charge to 63% of its full capacity, as well as how long it takes for it to discharge to 37% of its full capacity.

What device is used to measure the potential difference across a capacitor and how should be connected?

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A voltmeter should be connected in parallel across the ends of the capacitor.

What equation shows how the potential difference across a capacitor varies with time as it discharges?

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

Where V_0 is the initial pd across the capacitor.

What graph can be plotted to confirm that the change in the potential difference, across a capacitor as it discharges, follows an exponential decay trend?

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A graph of $\ln(V/V_0)$ against t can be plotted. This should form a straight line graph.

What is the advantage of taking logarithms before plotting an exponential relationship?

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Taking logarithms allows the exponential relationship to be more easily confirmed when plotted. It also allows the graph to be matched to the equation of a straight line, which means desired variables can be more easily ascertained.

When plotting a discharge graph of $\ln(V/V_0)$ against t, how can the capacitor's time constant be obtained?

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The graph will have an equation of

$$\ln(V) = \ln(V_0) - t/RC$$

and so the time constant (RC) is given by -1/gradient

What is the benefit of doing a trial discharge before carrying out this experiment in full?

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A trial discharge with your chosen values of R and C allows you to choose a suitable time interval to take recordings at, depending on how quickly the capacitor discharges.

What equation shows how the potential difference across a capacitor varies with time as it charges?

What equation shows how the potential difference across a capacitor varies with time as it charges?

$$V = V_0\left(1 - e^{\frac{-t}{RC}}\right)$$

Where V_0 is the pd across the fully-charged capacitor.

How does the charge across a capacitor vary with time as it discharges?

How does the charge across a capacitor vary with time as it discharges?

$$Q = Q_0 e^{\frac{-t}{RC}}$$

What is the relationship between a capacitor's time constant and the time taken for its voltage to fall to half its initial value?

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$$t_{\frac{1}{2}} = 0.69RC$$