2022 Ph H2 Q13

Section: Electricity

Topic: Capacitors

Experiment investigating charging of capacitor. (a) Describe how results are obtained and used to show V vs t. (b) Capacitor 47 μF charged to 12 V: (i) calculate maximum energy, (ii) suggest alteration to increase stored energy.

Worked solution

(a) Close switch S, start stopwatch at same time. Take repeated readings of capacitor voltage V using voltmeter at regular time intervals. Plot graph of V vs t to show the exponential charging curve. Alternatively, data logger could be used to record V continuously against t.

(b)(i) Maximum energy

$E = \frac{1}{2} C V^2$
$= 0.5 \times 47 \times 10^{-6} \times (12)^2$
$= 3.38\text{e-}03$ J

Answer: 3.4×10^{-3} J

(b)(ii) To increase maximum energy ($E = \frac{1}{2} C V^2$), increase either capacitance C or supply voltage V. For example, raise supply voltage above 12 V (if within capacitor rating).

Final answers

(a) Record V vs t, plot charging curve

(b)(i) E = 3.4×10^{-3} J

(b)(ii) Increase capacitance or voltage supply

Revision tips

- Charging follows exponential: V(t) = Vmax(1 − e^(−t/RC)).
- Energy stored in capacitor: ½ C V^2.
- Increasing supply voltage or capacitance increases stored energy.
- Use of stopwatch and voltmeter allows manual data collection.
- Capacitor fully charged when current falls to zero and V = supply voltage.