2024 Ph H1 Q21

Section: Electricity

Topic: Capacitors

Question Summary

An initially uncharged capacitor is charged for 20 s by a constant current of 0.10 mA. After this time, the p.d. across the capacitor is 12 V. Calculate the energy stored in the capacitor.

Worked Solution

Charge delivered by a constant current: $Q = I\,t$.
$I = 0.10\ \text{mA} = 1.0 \times 10^{-4}\ \text{A}$, $t = 20\ \text{s} \Rightarrow Q = 1.0 \times 10^{-4} \times 20 = 2.0 \times 10^{-3}\ \text{C}$.

Capacitance from $Q = C\,V \Rightarrow C = Q/V = (2.0 \times 10^{-3}) / 12 = 1.67 \times 10^{-4}\ \text{F}$.

Energy: $E = \tfrac{1}{2}\,C\,V^2 = \tfrac{1}{2} \times (1.67 \times 10^{-4}) \times 12^2 \approx 0.012\ \text{J} = 12.0\ \text{mJ}$.

Final Answer: B

Revision Tips

- With constant current charging, Q increases linearly: $Q = It$.
- Once V is known, find $C = Q/V$, then energy with $E = \tfrac{1}{2}\,C\,V^2$.
- Keep units straight: mA → A; J → mJ.