Capacitance

Fields · 4 questions · step-by-step answers at the end

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USEFUL EQUATIONS

$C = Q / V$ $W = \frac{1}{2}QV = \frac{1}{2}CV^2$ $x = x_0\, e^{-t/RC}$ $\tau = RC$

Questions

Show your working in the space under each question.

1. How long does the capacitor above take to fall to half its initial voltage?

2. A 470 µF capacitor is charged to 12 V and then discharged through a 10 kΩ resistor. Find the charge and energy stored, the time constant, and the p.d. after 4.7 s.

3. A 100 µF capacitor discharges through 22 kΩ. Find the time constant and the time for the p.d. to fall to 10% of its initial value.

4. Find the capacitance of plates 0.10 m × 0.10 m, 1.0 mm apart, filled with a dielectric of $\varepsilon_r = 4$.

Step-by-step answers

Capacitance

1. $t = RC \ln 2 = 4.7 \times 0.693 =$ **3.3 s**.

2. 1. $Q = CV = 470 \times 10^{-6} \times 12 =$ **5.6 mC**.
2. $W = \frac{1}{2}CV^2 = \frac{1}{2} \times 470 \times 10^{-6} \times 144 =$ **34 mJ**.
3. $\tau = RC = 10\,000 \times 470 \times 10^{-6} =$ **4.7 s**.
4. After one time constant $V = 12 \times e^{-1} =$ **4.4 V**.

Answer: 5.6 mC; 34 mJ; 4.7 s; 4.4 V

3. $\tau = 2.2$ s; $t = \tau \ln 10 =$ **5.1 s**.

4. $C = 8.85 \times 10^{-12} \times 4 \times 0.010 / 1.0 \times 10^{-3} =$ **3.5×10^{-10} F**.