



QUESTION WORKBOOK

The time constant and exponential decay

Capacitance · Year 13

AQA 3.7.4.4 · CIE 19.3 · OCR A 6.1.3

10 questions · 30 marks

NAVY SCREEN EDITION

SECTION A · Warm-up

A1 State the equation for the time constant of an RC circuit and what it represents.

[2]

A2 A $100\ \mu\text{F}$ capacitor discharges through a $10\ \text{k}\Omega$ resistor. Calculate the time constant.

[2]

A3 State the equation for the charge on a capacitor discharging through a resistor.

[2]

SECTION B · Standard

B1 A $470\ \mu\text{F}$ capacitor discharges through a $2.2\ \text{k}\Omega$ resistor. Calculate the time constant, and state what fraction of the initial charge remains after one time constant.

[3]

- B2** A $100\ \mu\text{F}$ capacitor is charged to $12\ \text{V}$ and discharged through a $47\ \text{k}\Omega$ resistor. Calculate the potential difference across it after $5.0\ \text{s}$. [4]

- B3** For that circuit ($RC = 4.7\ \text{s}$), calculate the half-life of the discharge using $T_{\frac{1}{2}} = 0.69RC$. [3]

- B4** A capacitor of $220\ \mu\text{F}$ is to have a time constant of $2.0\ \text{s}$. Calculate the resistance required. [3]

SECTION C · Stretch

- C1** A capacitor discharges through a resistor with a time constant of 3.0 s. Calculate the time taken for the voltage to fall from 20 V to 5.0 V. [4]

- C2** A 470 μF capacitor is charged from a 9.0 V supply through a 10 k Ω resistor. Calculate the potential difference across the capacitor after 10 s, using $V = V_0(1 - e^{-t/RC})$. [4]

- C3** Explain how the time constant RC can be found from a graph of $\ln(V)$ against time for a discharging capacitor. [3]