Exercise walk-through

RC Circuits ▪ 11.8

eXercise

You must be able to

- describe how a **capacitor 电容器** charges and discharges through a resistor over time
- relate the **time constant 时间常数** $\tau = RC$ to how quickly the circuit responds
- describe the current and voltage at the start and after a long time

Method — Charging and discharging

A capacitor charges up through a resistor, its voltage rising toward the supply value; it discharges the same way in reverse.

Method — Time constant

$\tau = RC$ (seconds) sets the pace: a bigger R or C means slower charging.

Method — Start and steady state

At $t = 0$ the uncharged capacitor acts like a **wire** (maximum current); after a long time it is **fully charged** and the current is **zero**.

Practice 2.1 ▪ 2 marks

Find the time constant of a $2000\ \Omega$ resistor and a $50\ \mu$F capacitor.

Solution 2.1

Worked steps

$\tau = RC = 2000 \times 50 \times 10^{-6} = 0.10$ s M1 A1.

Practice 2.2 ▪ 1 mark

State the current through the capacitor a long time after charging begins.

Solution 2.2

Method: Start and steady state

Worked steps

zero (the capacitor is fully charged) B1.

Practice 2.3 ▪ 1 mark

State what happens to the charging rate if the resistance is increased.

Solution 2.3

Worked steps

it slows down (a larger $\tau = RC$) B1.

Exam-style 3.1 ▪ 1 mark

The time constant of an RC circuit is

A R/C

B RC

C $R+C$

D C/R

Solution 3.1

Method: Time constant

A R/C

B RC ✓

C $R + C$

D C/R

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

A long time after charging begins, the current in an RC circuit is

A at its maximum

B zero

C constant and large

D negative

Solution 3.2

Method: Start and steady state

A at its maximum

B zero ✓

C constant and large

D negative

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

A 10 kΩ resistor charges a 100 μF capacitor from a 9.0 V supply.
(a) Find the time constant.
(b) State the final voltage across the capacitor.

Solution 3.3

Method: Charging and discharging

Worked steps

(a) $\tau = RC = (10 \times 10^3)(100 \times 10^{-6}) = 1.0$ s M1 A1. (b) 9.0 V (the supply voltage) B1.