InkPhysics

ANSWER BOOK

Charging and discharging

Capacitance · Year 13

AQA 3.7.4.4 · CIE 19.3 · OCR A 6.1.3

10 questions · 30 marks

NAVY EDITION

inkphysics.co.uk

SECTION A · Warm-up

A1 It is an exponential decay: the charge starts at its maximum and falls, quickly at first then ever more slowly, approaching zero but never quite reaching it. [2]

A2 The current is greatest at the instant charging begins and decreases exponentially towards zero as the capacitor becomes fully charged. [2]

A3 The current equals the gradient of the charge–time graph, $I = \Delta Q/\Delta t$. [2]

SECTION B · Standard

B1 $I_0 = V/R = 12/1000 = 0.012$ A (12 mA). [3]

B2 Initial current $I_0 = V/R = 6.0/2000 = 0.0030$ A (3.0 mA). The final current is 0, once the capacitor is fully charged. [3]

B3 The pd across the capacitor rises exponentially from 0 towards the supply voltage: as charge builds up, the pd across the resistor falls, so charging slows. The current starts at V/R and falls exponentially to zero, because the decreasing pd across the resistor (supply minus capacitor pd) drives an ever smaller current. [4]

B4 $Q = CV = 100 \times 10^{-6} \times 9.0 = 9.0 \times 10^{-4}$ C. $E = \tfrac{1}{2}CV^2 = \tfrac{1}{2} \times 100 \times 10^{-6} \times 9.0^2 = 4.050 \times 10^{-3}$ J. [3]

SECTION C · Stretch

C1 (a) $Q_0 = CV = 470 \times 10^{-6} \times 10 = 4.70 \times 10^{-3}$ C. (b) $I_0 = V/R = 10/2200 = 4.55 \times 10^{-3}$ A (4.5 mA). [4]

C2 All the stored energy is dissipated: $E = \tfrac{1}{2}CV^2 = \tfrac{1}{2} \times 1000 \times 10^{-6} \times 12^2 = 0.072$ J. [4]

C3 As the capacitor discharges, its charge and therefore the pd across it fall. Since the current is this pd divided by the resistance ($I = V/R$), a smaller pd drives a smaller current, so the current decreases as the discharge proceeds. [3]