

M1.D

[1]

M2.(a) (i) determine area under the graph
[or determine area between line and time axis] ✓

1

(ii) *as seen*
line starts at very low current (within bottom half of first square) ✓
either line continuing as (almost) horizontal straight line to end ✓✓
or very slight exponential decay curve ✓
which does not meet time axis ✓

OR suitable verbal comment that shows appreciation of difficulty of representing this line on the scales involved ✓✓✓

Use this scheme for answers which treat the information in the question literally.

3

as intended
line starts at half of original initial current ✓
slower discharging exponential (ie. smaller initial gradient)
than the original curve ✓
correct line that intersects the original curve
(or meets it at the end) ✓

Use this scheme for answers which assume that both resistance values should be in Ω or $k\Omega$.

$\frac{1}{2}$ initial current to be marked within $\pm 2\text{mm}$ of expected value.

3

(b) (i) energy stored ($= \frac{1}{2} CV^2$) = $\frac{1}{2} \times 0.12 \times 9.0^2$ ✓ (= 4.86 (J))
4.86 = 3.5 Δh ✓
gives $\Delta h = (1.39) = 1.4$ (m) ✓
to 2SF only ✓

SF mark is independent.

Students who make a PE in the 1st mark may still be awarded the remaining marks: treat as ECF.

- (ii) energy is lost through heating of wires **or** heating the motor
(as capacitor discharges) ✓
*Allow heating of circuit **or** $I^2 R$ heating.*

energy is lost in overcoming frictional forces in the motor
(or in other rotating parts) ✓
Location of energy loss (wires, or motor, etc) should be indicated in each correct answer.

[**or** any other well-expressed sensible reason that is valid
e.g. capacitor will not drive motor when voltage becomes low ✓]
Don't allow losses due to sound, air resistance or resistance (rather than heating of) wires.

max 2

[10]

M3.(a) (i) 7.5×10^{-6} (C) or $7.5 \mu\text{C}$

B1

1

- (ii) Suitable scale and charge from (i) correctly plotted at 2.5 V
*Large square = 1 or 2 μC **or**
With false origin then large square = 0.5 μC*

B1

Only a Straight line drawn through or toward origin

C1

Line must be straight, toward origin **and** only drawn between 2.5 V and 1.2 V ($\pm 1/2$ square on plotted points)

A1

3

- (b) Attempted use of $E = \frac{1}{2} CV^2$ Or attempted use of $E = \frac{1}{2} QV$

C1

9.38 (μJ) – 2.16 (μJ) seen
 or $E = \frac{1}{2} \times 3 \times 10^{-6} \times 2.5^2 - \frac{1}{2} \times 3 \times 10^{-6} \times 1.2^2$ seen
 or $E = \frac{1}{2} \times 3 \times 10^{-6} \times (2.5^2 - 1.2^2)$ seen
 or $E = \frac{1}{2} \times 7.5 \times 10^{-6} \times 2.5 - \frac{1}{2} \times 3.6 \times 10^{-6} \times 1.2$ seen

C1

7.2×10^{-6} (J) c.a.o

A1

3

(c) (i) Use of $V = V_0 e^{-\frac{t}{RC}}$
 or equivalent with
 $Q = Q_0 e^{-\frac{t}{RC}}$

$$R = - \left(\frac{1.4 \times 10^{-3}}{\ln\left(\frac{1.2}{2.5}\right) \times 3 \times 10^{-6}} \right) \quad \text{or } R = - \left(\frac{t}{\ln\left(\frac{V_0}{V}\right) \times C} \right) \quad \text{or } R = \left(\frac{t}{\ln\left(\frac{V_0}{V}\right) \times C} \right)$$

C1

C1

636 or 640 (Ω)

A1

3

(ii) Current decreases ($I = V / R$) / describes rate of flow of electrons decreasing / rate of flow of charge decreases

M1

Charge lost more slowly so pd falls more slowly
because $V \propto Q$ or $Q = CV$ where C is constant

A1

MAX 2

[12]

M4.D

[1]

