M1.D

[1]

M2.B

[1]

M3.A

[1]

M4.(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 kΩ.

½ initial current to be marked within ±2mm of expected value.

3

(b) (i) energy stored (= ½ CV^2) = ½ × 0.12 × 9.0^2 ✓ (= 4.86 (J))

4.86 = 3.5 Δ*h* ✓

gives Δ*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.

4

(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]

M5.(a) (i) 7.5×10^{-6} (C) or 7.5 μ(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 (± 1 / 2 square on plotted points)

A1

3

(b) Attempted use of E= ½ CV^2 Or attempted use of E=½ QV

C1

9.38 (μJ) − 2.16 (μJ) seen
or E = ½ × 3 × 10^{-6} × 2.5^2 – ½ × 3 × 10^{-6} × 1.2^2 *seen*
or E = ½ × 3 × 10^{-6} × (2.5^2 – 1.2^2) *seen*
or E =½ × 7.5 × 10^{-6} × 2.5 – ½ × 3.6 × 10^{-6} × 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

$Q = Q_0 e^{-\frac{t}{RC}}$

C1

R = $-\left(\frac{1.4\times10^{-3}}{ln\left(\frac{1.2}{2.5}\right)\times3\times10^{-6}}\right)$ or R = $-\left(\frac{t}{ln\left(\frac{V_o}{V}\right)\times C}\right)$ or R = $\left(\frac{t}{ln\left(\frac{V_o}{V}\right)\times C}\right)$

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 <u>so</u> pd falls more slowly
<u>because</u> V∝Q or Q=CV where C is constant

A1

MAX 2

[12]

M6.(a) $d = \frac{8.9\times10^{-12}\times2.3\times250\times10^{-4}}{370\times10^{-12}}$ ✓

1.4 ×10^{-3} m (1.4 (1.38) mm)✓

Data substitution – condone incorrect powers of 10 for C and A ✓

2

(b) New capacitance = 161 pF✓

New V = 0.13 nC / 161pF = 81 V✓

2

(c) Energy stored = ½ × 161 × 10^{-12} × 81^{2} ✓

0.53 μJ✓

2

(d) Energy increases because:

In the polar dielectric molecules align in the field with positive charged end toward the negative plate (or WTTE).✓

Work is done on the capacitor separating the positively charged surface of the dielectric from the negatively charged plate (or vice versa).✓

2

[8]

M7.C

[1]

M8.B

[1]

M9.B

[1]

M10.B

[1]

M11.D

[1]

M12.C

[1]

M13. D

[1]

M14. D

[1]

M15. D

[1]

M16. C

[1]