

Name of the Student: _____

Max. Marks : 26 Marks

Time : 26 Minutes

Mark Schemes

Q1.

- (a) Capacitor must not lose charge through the meter ✓ 1
- (b) Position on scale can be marked / easier to read quickly etc ✓ 1
- (c) Initial current = $\frac{6}{100000} = 60.0 \mu\text{A}$ ✓
 100 μA or 200 μA ✓ (250 probably gives too low a reading)
 Give max 1 mark if 65 μA (from 2.6) used and 100 μA meter chosen 2
- (d) 0.05 V ✓ 1
- (e) Total charge = $6.0 \times 680 \times 10^{-6}$ (C) (= 4.08 mC) ✓
 Time = $4.08 \times 10^{-3} / 60.0 \times 10^{-6} = 68$ s ✓
 Hence 6 readings ✓ 3
- (f) Recognition that total charge = 65 μC and final pd = 0.098 V ✓
 so $C = 65 \mu / 0.098$ ✓
 660 μF ✓
Allow 663 μF 2
- (g) (yes) because it could lie within 646 – 714 to be in tolerance ✓
 OR
 it is 97.5 % of quoted value which is within 5% ✓ 1
- (h) Suitable circuit drawn ✓
 Charge C then discharge through R and record V or I at 5 or 10 s intervals ✓

Plot $\ln V$ or $\ln I$ versus time ✓

gradient is $1 / RC$ ✓

OR

Suitable circuit drawn ✓

Charge C then discharge through R and record V or I at 5 or 10 s intervals ✓

Use V or I versus time data to deduce half-time to discharge ✓

$1 / RC = \ln 2 / t_{1/2}$ quoted ✓

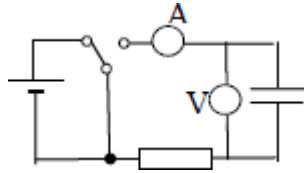
OR

Suitable circuit drawn ✓

Charge C then discharge through R and record V or I at 5 or 10 s intervals ✓

Plot V or I against t and find time T for V or I to fall to 0.37 of initial value ✓

$T = CR$ ✓



Either A or V required

For 2nd mark, credit use of datalogger for recording V or I .

4

[15]

Q2.

(a) (i) capacitance $= \left(\frac{Q}{V} \right) = \frac{98.2 - 73.9}{12.0 - 9.0}$ ✓

$= 8.1 \text{ } (\mu\text{F})$ ✓ ($\pm 0.2 \text{ } \mu\text{F}$)

1 mark only if correct value of C is found from a single point.

2 marks if correct value of C is found from at least 2 points and a mean value, or from gradient. (Check graph.)

Accept 8 (μF) if from correct working.

2

(ii) additional energy = area between line and Q or V axis ✓

$= \{ \frac{1}{2} \times (98.2 - 73.9) \times 3.0 \} + \{ (98.2 - 73.9) \times 9.0 \}$ ✓

$= \{ 36.5 + 218.7 \} = 255 \text{ J or } 2.6 \times 10^{-4} \text{ (J)}$ ✓

[or, using $\frac{1}{2} QV$:

additional energy $= \frac{1}{2} Q_2 V_2 - \frac{1}{2} Q_1 V_1$ ✓

$= \frac{1}{2} \{ (98.2 \times 12) - (73.9 \times 9) \}$ ✓

$= 257 \text{ } \mu\text{J or } 2.6 \times 10^{-4} \text{ (J)}$ ✓]

[or, using $\frac{1}{2} CV^2$:

$$\text{additional energy} = \frac{1}{2} CV_2^2 - \frac{1}{2} CV_1^2 \quad \checkmark$$

$$= \frac{1}{2} 8.1 \times (12^2 - 9^2) \quad \checkmark$$

$$= 255 \mu\text{J} \text{ or } 2.6 \times 10^{-4} \text{ (J)} \quad \checkmark]$$

[or, using $\frac{1}{2} Q^2/C$:

$$\text{additional energy} = \frac{1}{2} Q_2^2/C - \frac{1}{2} Q_1^2/C \quad \checkmark$$

$$= (98.2^2 - 73.9^2) \div (2 \times 8.1) \quad \checkmark$$

$$= 258 \mu\text{J} \text{ or } 2.6 \times 10^{-4} \text{ (J)} \quad \checkmark]$$

First scheme: alternative for 2nd mark

$$= \{ \frac{1}{2} \times (98.2 - 73.9) \times 3.0 \} + \{ 73.9 \times 3.0 \} \quad \checkmark$$

All schemes:

second mark subsumes the first mark.

In all methods, allow tolerance of $\pm 10 \mu\text{J}$ in final answer to allow for variation in graph measurements.

Allow ECF for incorrect C value from (a)(i).

3

(b) (i) $(V = V_0 e^{-t/RC} \text{ gives}) 0.2 V_0 = V_0 e^{-t/RC}$
and $0.2 = e^{-45/RC} \quad \checkmark$

Condone use of 0.8 for 0.2 in first mark only.

$$\ln 0.2 = \frac{-45}{RC} \quad \text{or} \quad \ln 5 = \frac{45}{RC} \quad \checkmark$$

$$\text{time constant } RC = \frac{45}{\ln 0.2} \quad \text{or} \quad \ln 5 = \frac{45}{RC} = 28.0 \text{ (s)} \quad \checkmark$$

3

(ii) resistance of $R = \left(\frac{\text{time constant}}{C} \right) = \frac{28.0}{470 \times 10^{-6}} \quad \checkmark$
 $= 5.96 \times 10^4 \text{ } (\Omega) \text{ or } 60 \text{ k}\Omega \quad \checkmark$

Allow ECF for incorrect RC value from (b)(i).

2

(ii) tick in 4th box **only**

1

[11]