Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Q1.

(a) tick in **first** box (2.7 V) ✔

[cao]

1

(b) move position until needle / pointer hides / is aligned with its reflection in the mirror or wtte $_1$✔

for $_1$✔ allow 'view scale so needle / pointer hides reflection';
condone 'there is no reflection'

this reduces / eliminates parallax error

OR

to ensure scale is read from directly above $_2$✔

for $_2$✔ reject 'reduces / eliminates human error'
allow 'reading is made when at right angles' / 'perpendicular to the scale';
reject 'view scale at eye level' / 'so not looking at an angle' / 'so not looking straight at needle'

2

(c) average $T_{½}$ correct

OR

uncertainty in $T_{½}$ correct $_1$✔

for $_1$✔ average $T_{½}$ = 12.04 (s); reject 12.0
allow credit for correct $T_{½}$ seen in working for percentage uncertainty;
uncertainty in $T_{½}$ (from half range) = 0.11 (s)

1

percentage uncertainty in $T_{½}$ correct $_2$✔

for $_2$✔ minimum 2 sf;
correct answer rounds to 0.91(4)%

1

(d) time constant = $\frac{\text{their mean } T_{½}}{\ln 2}$

OR

$\frac{-(\text{their mean } T_{½})}{}$ ✓

expect 17.37 (s);

allow minimum 3 sf 17.4 / use of ln 2 = 0.69 for leading to 17.45;

reject use of $T_{½}$ = 12 leading to 17.31;

reject $\frac{\text{their mean } T_{½}}{\ln 0.5}$ (ignoring −sign in result)

1

(e) ways ensure pd across **C** doesn't exceed 3 V

before connecting **C** to **X** $_1$✔

as **X** is connected $_2$✔

*for $_1$✔ discharge **C** / connect flying lead to **Y** / 'reset to 0 V' (before reconnecting);*

reject 'reset equipment'

*for $_2$✔ reduce the output pd / socket **X** (or wtte) to ≤ 3 V (then reconnect **C** and adjust pd so meter reads full-scale);*

*reject 'only charge **C** to 3 V'*

idea of adding resistance to limit pd is neutral

Max 3

suggests timing for ΔV > 1.5 V or wtte $_{3a}$✔

OR

take repeated readings (of $T_{½}$ or time constant);

any valid processing eg calculate an average value / reject anomalies / check results are concordant or wtte $_{3b}$✔

check / correct / compensate for any zero error (on the voltmeter) $_4$✔

suggests a valid quantitative test of theory by comparison with the result obtained using the 15 V range $_5$✔

for $_{3a}$✔ accept 'increase timing interval' / time for concurrent half lives or wtte;

*reject 'measure time for **C** to fully discharge'*

for $_{3b}$✔ accept 'repeat the experiment and calculate a mean' only if this refers to

reject 'repeat etc to get more reliable result'

for $_4$✔ accept 'check etc for systematic error'

'student' is repeating previous experiment so reject idea of making V the dependent variable / plot V against t / using data logging

(theory will be correct if) half-life / time constant is one fifth / 20% (of previous value) / about 3.5 s / time constant reduced by 80% / ratio of time constant to range / ratio of half-life to range is same / similar

reject 'plot ln V against t, find (−gradient^{-1})'

1

(f) in answer space 1:

any valid comment about the values of V in **Table 2** $_1$✔

corresponding explanation $_2$✔ (contingent on $_1$✔)

give credit for any good physics, eg

V recorded to nearest volt $_1$✔

because of (low) scale resolution / hard to interpolate between markings; reject 'values easier to plot' $_2$✔

in answer space 2:

different valid comment about the values of V in **Table 2** $_3$✔

corresponding explanation $_4$✔ (contingent on $_3$✔)

different / decreasing intervals between values of V / more lower values of V $_3$✔

to make intervals between t readings about the same / or wtte; allow 'to distribute data on graph' or wtte / to allow (convenient interval for) t to be read / recorded $_4$✔

only credit one comment and explanation per answer space

comments about the number of data sets are neutral

no readings for V < 2 V / smallest V = 2 V $_5$✔

because difficult to establish exact moment to read stopwatch / needle is moving too slowly / sensible comment about parallax $_6$✔

V data over wide range / from 14 to 2 (V) $_7$✔

to maximise evidence available (for graph / ***Figure 8****) or wtte* $_8$✔

no readings for V > 14 V / largest V = 14 V $_9$✔

can begin discharge ***C*** *before starting stopwatch* $_{10}$✔

4

(g) attempts gradient calculation using $\Delta\ln(V / \text{V})$ divided by Δt;

use of $|\text{gradient}| = \left|\frac{-1}{R \times C}\right|$ $_{1a}$✓

for $_{1a}$✔ *expected gradient is −0.077;*

condone one read-off error in gradient calculation or missing sign;

allow any subject / (at least) substitution of their gradient into a valid calculation for R

condone missing / wrong POT for capacitance

OR

reads off ln V_0, ln V and corresponding Δt from **Figure 3**;

use of $V = V_0 e^{-\frac{t}{RC}}$ $_{1b}$✓

for $_{1b}$✔ *condone one read off error;*

allow any subject / (at least) substitution of all their data into a valid calculation for R

condone missing / wrong POT for capacitance

$_{1b}$✔variation below:

reads off ln $V0$ and finds $V0$ = 14.1 (V);

$V = 0.37V_0$ when $t = RC \therefore V = 0.37V_0 = 5.2\,\text{V}$

reads of ln 5.2 = 1.65; $\Delta t \approx 13$ (s) $\therefore R = \dfrac{13}{C}$

valid working leading to

voltmeter resistance ≥ 3 sf in range 15.0 kΩ to 16.6 kΩ $_2$✔

voltmeter resistance ≥ 3 sf in range 15.5 kΩ to 16.1 kΩ $_3$✔

accept > 3 sf that rounds to 3 sf in range

allow $_{23}$✔ = 1 MAX for POT error

*allow $_{123}$✔ = 1 MAX for using **Table 2** data*

3

(h) reads ln(V_{10} / V) from **Figure 8**;

deduces V_{10} in range 6.36 to 6.69 (V) $_1$✔

for $_1$✔ V_{10} to ≥ 3 sf required;

accept > 3 sf that rounds to 3 sf in range;

accept V_0 from ln V_0 read off and V_{10} deduced

from $V_{10} = V_0 e^{\frac{-10}{CR}}$;

condone use of V_0 = 15(V);

if V_{10} is not recorded allow $_1$✔ for use of $e^{\ln V_{10}}$ in the calculation of I_{10}

where ln(V_{10} / V) is in the range 1.85 to 1.90

1

≥ 2 sf result in range 3.9 to 4.3 × 10^{-4} (A) $_2$✔

for $_2$✔ allow use of resistance = 16 × 10^3 (Ω);

accept ≥ 3 sf result that rounds to 2 sf in range

*allow ECF if $V10$ is **correctly obtained** from an incorrect ln(V_{10} / V) read off and I_{10}*

calculated using $\dfrac{\text{their } V_{10}}{\text{their voltmeter resistance}}$

1

[19]