MARKING SCHEME UCE 535-3 PHY 3 2022

Question 1

T_1 — **$1\frac{1}{2}$**

Design of table of results of at least 5-cloumns with l-column labelled with unit and all the l-values entered in the stated order

Conditions to award the marks

Design ($\frac{1}{2}$ mark)

- Table must be enclosed.
- Table must have at least 5 columns.
- Table should be drawn using a pen (accept pencil).

Label ($\frac{1}{2}$ mark)

- The symbol l must be correctly written (i.e. should be consistent with that used in the instructions)
- Unit of l should be written correctly using the right symbol
- Unit should be in brackets and on the same line with the quantity l i.e l (m)

Given values ($\frac{1}{2}$ mark)

- Should be in the right order.
- Should be written in the first column of the table.
- Should not be converted to other units.

T_2 — **2**

Labelling of the rest of the columns with units i.e. $t(s)$, $f(s^{-1})$ or $f\ (Hz)$, $f^2(s^{-2})$ or $f(Hz^2)$ and $\frac{1}{l}(m^{-1})$ (@ $\frac{1}{2}$ mark)

Conditions

- Correct symbols with correct units must be used.
- $\frac{1}{l}$ correctly written. Not $1/_l$

l(m)	$t(s)$	$f(s^{-1})$ or $f\ (Hz)$	$f^2(s^{-2})$ or $f(Hz^2)$	$\frac{1}{l}(m^{-1})$
0.900	**35.0-40.0**			**1.11**
0.800	**33.0-38.0**			**1.25**
0.700	**31.0-36.0**			**1.43**
0.600	**29.0-33.0**			**1.67**
0.500	**26.0-30.0**			**2.00**
0.400	**23.0-27.0**			**2.50**

T_3 — **6**

- Recording 6 values of t (@ **1 mark**)

Conditions

- Values should be decreasing
- Values should be written to 0dp, 1dp or 2dp.
  For 1dp the digit after the decimal point should be 0 or 5

	• Experimental values of t should lie within the ranges shown in the table above. - Recording 6 values of f correctly calculated (@ $\frac{1}{2}$ mark) **Conditions** • Base on the knowledge of significant figures to fix the correct number of dps in the f-column using the largest value in t-column. • Values should be correctly rounded off. - Recording correctly calculated values of f^2 {*correct 2* - $\frac{1}{2}$ mk, *3* – 1 mk, *4* – 1 mk, *5*- $1\frac{1}{2}$ mks, *6* - 2 mks} **Conditions** • Base on the knowledge of significant figures to fix the correct number of dps in the f^2-column using the largest value in the f-column. • Values should be correctly rounded off. - Recording correctly calculated values of $\frac{1}{l}$ {*correct 2* - $\frac{1}{2}$ mk, *3* – 1 mk, *4* – 1 mk, *5*- $1\frac{1}{2}$ mks, *6* - 2 mks} **Conditions** • Base on the knowledge of significant figures to fix the correct number of dps in the $\frac{1}{l}$-column using the largest value in the l-column. • Values should be correctly rounded off.	**3** **2** **2**
		$16\frac{1}{2}$
G_1	Title of the graph: (graph of f^2against $\frac{1}{l}$) **Conditions** ▪ Correct symbols with no units ▪ Correct spelling of "against" ▪ Accept "versus" instead of "against". Deny "Vs", "verses"	**1**
G_2	Drawing and labelling axes with units **Conditions** ***Drawing axes with arrows***: (@ $\frac{1}{2}$ mk) ▪ The vertical and horizontal line should meet (intersect). ▪ The arrow should touch the line. ▪ No double arrows on the same axis. ▪ Arrows should be within the grid not outside the grid.	**2**

	Labelling axes (@ $\frac{1}{2}$ mk) ▪ Correct symbols with correct units in brackets. ▪ Avoid double labelling on the same axis e.g. writing $f^2(s^{-2})$ and y-axis, on the same axis ▪ The label should be above 50% of the axis.	
G_3	Suitable and convenient scales (@ 1 mk) **Conditions** ▪ Axes must be demarcated (or marked). ▪ Scale should be multiple or submultiple of 1, 2, 2.5 or 5. ▪ Starting value must be indicated and should be a multiple of the scale. ▪ Starting value and last value on a given axis should enclose the first and last value in the table. ▪ Scale should cover at least 50% of the graph page. ▪ Scale should be uniform. ▪ Redundant values must not be there. e.g. 1.2**53**, 1.4**53**, … in this case 5 and 3 are redundant. ▪ Axes must meet	**2**
G_4	Correctly plotting 6 points (@ $\frac{1}{2}$ mk) **Conditions** ▪ Use ⊙⊗⊕, or $\cdot \times +$. ▪ Deny "shading of dots" or "use of ⋆ "	**3**
G_5	Best straight line **Conditions** ▪ At least <u>three</u> points correctly plotted. ▪ Line should be straight (continuous) and follow the trend of the experiment. ▪ Should pass through most of the plotted points (or average the points). ▪ Should go beyond the last and first plotted points. ▪ Line should not go beyond the grid of the graph paper. ▪ For **distortion**, do not score (award) the mark for the line.	**1**
G_6	Method of finding the slope **Conditions** - At least <u>two</u> points correctly plotted. - Large right triangle should be drawn at least 50% on either sides or one side. - If no triangle drawn, the points to be read should be indicated and they should be far apart.	**1**
		10

C_1	Calculation of the slope, S - Substitution ($\frac{1}{2}$ mk) - Arithmetic ($\frac{1}{2}$ mk) - Unit (ms^{-2} *or* mHz^2) ($\frac{1}{2}$ mk) **Conditions** ▪ At least 2 points correctly plotted. ▪ For substitution; the number of dps of the values substituted (i.e. read from the graph) should be the same as the number of dps of 1 small square on a given axis. ▪ For Arithmetic; dps should be correctly considered while subtracting; significant figures should be correctly considered while dividing. ▪ Unit; correct symbols should be used. Deny m/s^2	$1\frac{1}{2}$
C_2	Calculation of the constant, K - Substitution ($\frac{1}{2}$ mk) - Arithmetic ($\frac{1}{2}$ mk) - Accuracy ($9.0 - 11.0$) ($\frac{1}{2}$ mk) **Conditions** ▪ Substitution: At least one value for slope is read correctly from the graph. ▪ Arithmetic: Award for correct data manipulation. ▪ Accuracy: o At least three experimental values are correct. o At least three values correctly calculated in each of the included columns. o At least three points must be correctly plotted. o Line of best fit must be correct. o C_1 must be correct i.e. both substitution and arithmetic must be correct at C_1. o Value must come by calculation and directly fall within the given range not by rounding off. E.g. suppose a learner gets 8.9 which he/she rounds off to 9.0 then no mark is awarded.	$1\frac{1}{2}$
E	Possible source of error in the experiment ❖ *Air resistance, parallax (i.e. not reading the exact value), elongation of the thread, counting number of oscillations poorly, movement/shaking of the retort stand, faulty apparatus like stop clock.*	$\frac{1}{2}$
		$3\frac{1}{2}$
	TOTAL	**30**

<table>
<tr><td></td><td>Question 2</td><td></td></tr>
<tr><td>D_1</td><td>Drawing a straight line XY in the middle of the white sheet of paper, marking point, O, in the middle of XY and drawing a normal MO to XY</td><td>$\frac{1}{2}$</td></tr>
<tr><td>D_2</td><td>Drawing a line AO such that angle, $\alpha = 10°$, and fixing pins P_1 and P_2 along AO</td><td>$\frac{1}{2}$</td></tr>
<tr><td>D_3</td><td>Fixing pins P_3 and P_4 such that they appear to be in line with the images of P_1 and P_2 in the mirror and drawing a line BO through P_3 and P_4</td><td>$\frac{1}{2}$</td></tr>
<tr><td></td><td></td><td>$1\frac{1}{2}$</td></tr>
<tr><td>T_1</td><td><u>Design</u> of table of results of at least 5-columns with α-column <u>labelled with unit</u> and all the α-values entered in the <u>stated order</u></td><td>$1\frac{1}{2}$</td></tr>
<tr><td>T_2</td><td>Labelling of the rest of the columns with units for β and (90-β); and $sin\,\alpha$ and $sin(90-\beta)$ without units (@ $\frac{1}{2}$ mk)
<table>
<tr><th>α(°)</th><th>β(°)</th><th>$(90-\beta)$(°)</th><th>$\sin\alpha$</th><th>$\sin(90-\beta)$</th></tr>
<tr><td>10</td><td>78-82</td><td></td><td>0.174</td><td></td></tr>
<tr><td>20</td><td>68-72</td><td></td><td>0.342</td><td></td></tr>
<tr><td>30</td><td>58-62</td><td></td><td>0.500</td><td></td></tr>
<tr><td>40</td><td>48-52</td><td></td><td>0.643</td><td></td></tr>
<tr><td>50</td><td>38-42</td><td></td><td>0.766</td><td></td></tr>
<tr><td>60</td><td>28-32</td><td></td><td>0.866</td><td></td></tr>
</table></td><td>2</td></tr>
<tr><td>T_3</td><td>- Recording 6 values of β; decreasing to no dp within the given range (@ 1 mk)
- Recording 6 values of $(90-\beta)$ correctly calculated to no dp (@ $\frac{1}{2}$ mk)
- Recording correctly calculated values of $sin\,\alpha$ to 3dps {correct 2 - $\frac{1}{2}$ mk, 3 – 1 mk, 4 – 1 mk, 5- $1\frac{1}{2}$ mks, 6 - 2 mks}
- Recording correctly calculated values of $\sin(90-\beta)$ to 3dps {correct 2 - $\frac{1}{2}$ mk, 3 – 1 mk, 4 – 1 mk, 5- $1\frac{1}{2}$ mks, 6 - 2 mks}</td><td>6
3
2
2</td></tr>
<tr><td></td><td></td><td>$16\frac{1}{2}$</td></tr>
<tr><td>G_1</td><td>Title of the graph: [graph of $sin\,\alpha$ against $(90-\beta)$]</td><td>1</td></tr>
<tr><td>G_2</td><td>Drawing and labelling of axes <u>without</u> units
Drawing (@ $\frac{1}{2}$ mk); labelling (@ $\frac{1}{2}$ mk)</td><td>2</td></tr>
<tr><td>G_3</td><td>Suitable and convenient scales (@ 1 mk)</td><td>2</td></tr>
<tr><td>G_4</td><td>Correctly plotting 6 points (@ $\frac{1}{2}$ mk)</td><td>3</td></tr>
<tr><td>G_5</td><td>Best straight line</td><td>1</td></tr>
</table>

G_6	Method of finding the slope	**1**
		10
C_1	Calculation of the slope, S - Substitution ($\frac{1}{2}$ mk) - Arithmetic ($\frac{1}{2}$ mk) - Accuracy $(0.8 - 1.2)$($\frac{1}{2}$ mk)	$\mathbf{1\frac{1}{2}}$
E	Relationship between α and $(90 - \beta)$ ❖ *α and $(90 - \beta)$ are equal or are almost equal to each other.*	$\frac{1}{2}$
		2
	TOTAL	**30**
	Question 3	
R_1	Recording the value of E with unit **Conditions** - Value of E should be within the range (2.60-3.40) to 1dp or 2dps. For 2dps, the value in the second decimal place should be 0 or 5 and only even if the value of E is a multiple of 0.06. ($\frac{1}{2}$ mk) - Unit: V ($\frac{1}{2}$ mk)	**1**
T_1	Design of table of results of at least 6-columns with l-column labelled with unit and all the l-values entered in the stated order	$\mathbf{1\frac{1}{2}}$
T_2	Labelling of the rest of the columns with units for $I, V, \frac{V}{I}$, $(E - V)$ and no unit for $\frac{E}{(E-V)}$ (any 4 correct, @ $\frac{1}{2}$ mk)	**2**

l(cm)	$I(A)$	$V(V)$	$\frac{V}{I}$ (Ω or VA^{-1})	$(E\text{-}V)(V)$	$\frac{E}{(E-V)}$
20	**0.40-0.94**	**0.70-3.00**			
30	**0.34-0.82**	**0.95-3.05**			
40	**0.28-0.72**	**1.15-3.10**			
50	**0.26-0.66**	**1.30-3.15**			
60	**0.22-0.60**	**1.40-3.20**			
70	**0.20-0.54**	**1.50-3.20**			

T_3	- Recording 6 values of I decreasing to 2dps (@ $\frac{1}{2}$ mk)	**3**
	- Recording 6 values of V increasing to 1dp or 2dps *Allow a value that repeats once.* (@ $\frac{1}{2}$ mk)	**3**
	- Recording correctly calculated values of $\frac{V}{I}$ {*correct 2* - $\frac{1}{2}$ mk, *3* – 1 mk, *4* – 1 mk, *5*- $1\frac{1}{2}$ mks, *6* - 2 mks}	**2**

	- Recording correctly calculated values of $(E-V)$ {*correct 2* - $\frac{1}{2}$ mk, *3* – 1 mk, *4* – 1 mk, *5*- $1\frac{1}{2}$ mks, *6* - 2 mks} - Recording correctly calculated values of $\frac{E}{(E-V)}$ {*correct 2* - $\frac{1}{2}$ mk, *3* – 1 mk, *4* – 1 mk, *5*- $1\frac{1}{2}$ mks, *6* - 2 mks}	**2** **2**
		16$\frac{1}{2}$
G_1	Title of the graph: [graph of $\frac{E}{(E-V)}$ against $\frac{V}{I}$]	**1**
G_2	Drawing and labelling of axes with units for $\frac{V}{I}$ and no unit for $\frac{E}{(E-V)}$. [*Drawing* (@ $\frac{1}{2}$ mk); *labelling* (@ $\frac{1}{2}$ mk)]	**2**
G_3	Suitable and convenient scales (@ 1 mk)	**2**
G_4	Correctly plotting 6 points. (@ $\frac{1}{2}$ mk)	**3**
G_5	Best straight line	**1**
G_6	Method of finding the slope	**1**
		10
C_1	Calculation of the slope, S - Substitution ($\frac{1}{2}$ mk) - Arithmetic ($\frac{1}{2}$ mk) - Unit (Ω^{-1} or AV^{-1}) ($\frac{1}{2}$ mk)	**1$\frac{1}{2}$**
C_2	Calculation of the slope, S - Substitution / Arithmetic } ($\frac{1}{2}$ mk) - Unit (Ω or VA^{-1}) ($\frac{1}{2}$ mk) - Accuracy (0.5-2.0) ($\frac{1}{2}$ mk)	**1$\frac{1}{2}$**
E	Possible source of errors in the experiment ❖ *Loose connections, insensitivity of the instrument, parallax, over stayed cells, faulty apparatus.*	**$\frac{1}{2}$**
		3$\frac{1}{2}$
	TOTAL	**30**

AREAS OF CONCERN

1. **Fabricated values**

- These are values that an instrument cannot read.

How to award.

- ❖ Do not award marks for the next columns that will depend on them.
- ❖ Do not award mark for the scale that depends on these values.
- ❖ Do not award marks for plotting, best straight line and method of slope
- ❖ All C's collapse, except units.

2. **Trend violation**

- Values that do not follow the trend of the experiment.

How to award

- ❖ Award marks for the next columns that depend on them as long as they are correctly calculated.
- ❖ Score from G_1 up to G_4 if correct, then $G_5 = 0$, $G_6 = 0$.
- ❖ All C's collapse, except units

Note: In electricity experiments allow a value that repeats once.

3. **No Tracing paper (on Qn. 2)**

How to award

- Do not award/score the D's.
- Do not award marks for the measured values.
- Award marks for the next columns which involve calculation
- Score the graph
- Score the C's

Note:

Tracing should be on a plain sheet of paper. If the learner traces on the **answer booklet (ruled paper)** then do not score the D's. However, award marks for experimental values and proceed.

4. Conversion of given values e.g. in **question 1**, converting values of l which are supposed to be in metres to cm.

- Deny a half mark for stating values if converted values appear in first column.
- Deny a half mark for label if it has unit as cm in table.
- However, mark the data manipulation of these values in cm, scale, plotting, best straight line, method of slope, C's except unit unless the learner converts the value to the expected unit.

5. In **question 3**, If learner does not indicate the value for E, the examiner should establish the value of E.
   - If E is constant, deny $(E-V)$-column values, then award for $\frac{E}{(E-V)}$ and proceed to the graph.
   - If E varies, then deny values of $(E-V)$ and $\frac{E}{(E-V)}$, then allow plotting.

6. **Error in principle**

- Using wrong formula instead of the expected one. E.g. in **question 1,** if a leaner uses $f=\frac{t}{20}$ instead of $f=\frac{20}{t}$;
  - Then do not award marks for the values in the f-column, also do not award marks for columns that depend on f.
  - Do not award marks for G_3 to G_6.

7. **Interchange of axes**

Case 1: Both values and labels interchanged.
- Do not award marks for the labels and plotting.

Case 2: Values interchanged but labels not interchanged.
- Award marks for the label.
- Do not award plotting.

Case 3: Labels interchanged but values not interchanged.
- Do not award marks for the labels.
- Award marks for the scale and proceed to plotting.

8. **Distortions**

These are as a result of non-uniformity of the scale.
They are of two kinds i.e. ***single distortion*** and ***double distortion***.

<u>Single distortion</u>

(a) Distortion at the beginning or at the end

This occurs at the first 2 cm or at the last 2 cm.

- G_3-check the scale of the unaffected axis, if correct award a mark.
- G_4 award for points correctly plotted in the <u>undistorted</u> area.
- G_5 do not score (since line is assumed to be continuous)
- G_6 – do not score if the right-angled triangle reaches the affected region.

  If the method of finding the slope does not reach the affected region, award the mark and proceed to C's

(b) Distortion in the middle

This occurs after 2 cm and before the last 2 cm.

- G_3-check the scale of the unaffected axis, if correct award a mark. However, $G_4 - 0$, $G_5 - 0$, $G_6 - 0$
- For C's score only for the unit.

Double distortion

(i) On the same axis

- G_3-check the scale of the unaffected axis, if correct award a mark. However, $G_4 - 0$, $G_5 - 0$, $G_6 - 0$
- For C's score only for the unit.

(ii) On both axes

- $G_3 - 0, G_4 - 0$, $G_5 - 0$, $G_6 - 0$
- For C's score only for the unit.

9. In design of the table of results, ***tolerate*** small gaps at the edges of the table. Gaps should be smaller than the size of a row or a column.

10. For light experiments, accept α as a. For the case of beta, β, the tail should be indicated.

11. For time t, do not accept + instead of t.

END