Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2022**

MARK SCHEME

Maximum Mark: 30

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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This document consists of **9** printed pages.

Question	Answer	Marks
1	**Defining the problem**	
	z is the independent variable and t is the dependent variable **or** vary z and measure t	**1**
	keep B **and** A <u>constant</u>	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • pin/rod though hole • supported by a stand • sheet able to oscillate freely • at least one label from copper/sheet, hole, clamp stand, rod, pin	**1**
	use of stop-watch/timer to measure t (from release to stopping) **or** use of stop-watch/timer to measure time for the sheet (to stop) oscillating	**1**
	use of micrometer to measure z	**1**
	use of rule(r) to measure lengths to determine A **and** A = length × breadth	**1**
	Method of Analysis	
	plot a graph of lg t against lg z or equivalent (e.g. ln t against ln z)	**1**
	$q =$ gradient	**1**
	$K = AB\rho \times 10^{y\text{-intercept}}$ ($K = AB\rho \times e^{y\text{-intercept}}$ for ln t against ln z)	**1**

Question	Answer	Marks
1	**Additional detail including safety considerations**	**6**
	D1 use of cushion / sand box <u>in case sheet falls</u> **or** use gloves to protect hands from <u>cuts / sharp edges</u>	
	D2 keep (initial) distance between (copper) sheet and (poles of) magnet <u>constant</u> **or** keep (initial) distance between (copper) sheet and coil(s) <u>constant</u>	
	D3 keep initial displacement (of copper sheet) <u>constant</u>	
	D4 method to ensure initial displacement (of copper sheet) is constant, e.g. initially line up (corner of) plate with fiducial marker/vertical pin	
	D5 relationship valid <u>if</u> a straight line (with *y*-intercept = $\log\left(\frac{K}{AB\rho}\right)$) is produced	
	D6 repeat measurements of *z* <u>in different positions</u> and <u>average</u> *z*	
	D7 measure *B* / magnetic flux density using a (calibrated) Hall probe	
	D8 additional detail on use of Hall probe, e.g. adjust (position of) probe until maximum value **or** measure *B* using Hall probe first in one direction and then in the opposite direction and average	
	D9 drawn method to create a magnetic field perpendicular to the area of the sheet, e.g. pair of magnets/horseshoe magnet/pair of coils connected to a (d.c.) supply	
	D10 repeat experiment for each *z* and average *t*	
	D11 method to determine ρ, e.g. measure mass with balance **and** volume = *Az* **and** density = mass / volume	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $\dfrac{c}{2h}$
y-intercept = $-\dfrac{c}{4h}$</td><td>1</td></tr>
<tr><td rowspan="2">2(b)</td><td>
<table>
<tr><th>T / ms</th><th>f / Hz</th><th></th></tr>
<tr><td>7.0 or 7.00 ± 1</td><td>140 or 143</td><td>± (10–30)</td></tr>
<tr><td>2.9 or 2.90 ± 0.2</td><td>340 or 345</td><td>± (20–30)</td></tr>
<tr><td>1.8 or 1.80 ± 0.1</td><td>560 or 556</td><td>± 30</td></tr>
<tr><td>1.4 or 1.35 ± 0.1</td><td>710 or 714
or
740 or 741</td><td>± (40–60)</td></tr>
<tr><td>1.1 or 1.05 ± 0.1</td><td>910 or 909
or
950 or 952</td><td>± (80–100)</td></tr>
<tr><td>0.88 or 0.880 ± 0.02</td><td>1100 or 1140</td><td>± (30–60)</td></tr>
</table>
Values of T and f correct as shown above.</td><td>1</td></tr>
<tr><td>Absolute uncertainties in T and f correct as shown above.</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>Six points from **(b)** plotted correctly.
Must be within half a small square. Diameter of points must be less than half a small square.</td><td>1</td></tr>
<tr><td>Error bars in f plotted correctly.
All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(c)(ii)	Straight line of best fit drawn. Points must be balanced. Do not accept line from top point to bottom point. Line must pass between (2.20, 400) and (2.40, 400) **and** (5.20, 1000) and (5.60, 1000).	**1**
	Worst acceptable line drawn (steepest or shallowest possible line that passes through all the error bars). All error bars must be plotted.	**1**
2(c)(iii)	Gradient determined with clear substitution of data points into $\Delta y / \Delta x$. Distance between data points must be greater than half the length of the drawn line.	**1**
	Gradient of worst acceptable line determined with clear substitution of data points into $\Delta y / \Delta x$. uncertainty = (gradient of line of best fit **–** gradient of worst acceptable line) **or** uncertainty = ½ (steepest worst line gradient **–** shallowest worst line gradient)	**1**
2(d)	83.2 ± 0.3 (cm)	**1**
2(e)(i)	*c* determined using gradient **and** *c* given to two or three significant figures. $c = 2 \times h \times$ gradient $= 2 \times$ **(d)** $\times$ **(c)(iii)**	**1**
	c determined using gradient **and** given with correct SI unit **and** correct power of ten: m s^{-1} or cm s^{-1}.	**1**
2(e)(ii)	Percentage uncertainty in *c* from **(c)(iii)** and **(d)** with method shown. $\text{percentage uncertainty} = \left(\frac{\Delta h}{h} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$ **or** correct substitution for max/min methods: max $c = 2 \times$ max $h \times$ max gradient min $c = 2 \times$ min $h \times$ min gradient	**1**

Question	Answer	Marks
2(f)	*h* determined to at least two significant figures from **(e)(i)** with correct substitution. $h = \dfrac{3 \times \textbf{(e)(i)}}{4 \times 130}$	**1**
	Absolute uncertainty in *h* determined. Correct substitution must be seen. $\Delta h = \left(\dfrac{\Delta f}{f} + \dfrac{\Delta c}{c}\right) \times h = \left(\dfrac{5}{130} + \dfrac{\Delta c}{c}\right) \times h$ **or** correct substitution for max/min methods: $\max h = \dfrac{3 \times \max\ c}{4 \times \min\ f} = \dfrac{3 \times \max\textbf{(e)(i)}}{4 \times 125}$ $\min h = \dfrac{3 \times \min\ c}{4 \times \max\ f} = \dfrac{3 \times \min\textbf{(e)(i)}}{4 \times 135}$	**1**