Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2023**

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1	**Defining the problem**	
	R is the independent variable and *E* is the dependent variable **or** vary *R* and measure *E*	**1**
	keep *V* constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • coil P placed close to coil Q • separate workable circuit for coil Q • (a.c.) voltmeter or oscilloscope connected across coil Q (Do not accept a power supply connected to coil Q.)	**1**
	a.c. power supply/signal generator connected to resistor and coil P in series	**1**
	workable circuit with power supply and (a.c.) voltmeter/oscilloscope in parallel with resistor and coil P or across terminals of power supply/signal generator	**1**
	method to determine *R*, e.g. measure current in *R* and p.d. across *R* and use $R = V_R/I$ **or** measure *R* using an ohmmeter	**1**

Question	Answer	Marks
1	**Method of Analysis**	
	plot a graph of $\frac{1}{E}$ against R or equivalent (e.g. R against $\frac{1}{E}$) Do not accept logarithms.	**1**
	$M = \frac{1}{2\pi fV \times \text{gradient}}$ (for R against $\frac{1}{E}$: $M = \frac{\text{gradient}}{2\pi fV}$)	**1**
	$k = 2\pi fVM \times y$-intercept **or** $k = \frac{y\text{-intercept}}{\text{gradient}}$ (for R against $\frac{1}{E}$: $k = -y$-intercept)	**1**

Question	Answer	Marks
1	**Additional detail including safety considerations**	**6**
	D1 precaution linked to hot coil (P) / hot resistor, e.g. use of (heat-proof) gloves, wait until circuit cools down **or** precaution linked to shocks from high voltages e.g. use of (insulating) gloves or switch off supply before touching the circuit (to change R)	
	D2 keep the number of turns on (both) coils constant	
	D3 keep f constant	
	D4 keep distance between the coils constant	
	D5 method to keep distance between the coils constant, e.g. fix/clamp coils to bench	
	D6 method to measure f, e.g. read from signal generator or use of oscilloscope	
	D7 method to determine f from oscilloscope, e.g. period from oscilloscope T = time-base × horizontal distance **and** $f = 1/T$	
	D8 method to determine V or E from oscilloscope, e.g. V = y-gain × vertical distance	
	D9 method to increase E e.g. use iron core/more turns on coil Q/high frequency/high p.d. (across R and coil P)	
	D10 relationship valid if a straight line is produced (not passing through the origin) Do not accept straight line passing through the origin.	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $\frac{Yk}{p}$
y-intercept = $\frac{YkZ}{p}$</td><td>1</td></tr>
<tr><td rowspan="2">2(b)</td><td><table><tr><th>V / 10^{-5} m^3</th><th>absolute uncertainty</th></tr><tr><td>3.81 or 3.815</td><td>± 0.03</td></tr><tr><td>3.99 or 3.986</td><td>± 0.03</td></tr><tr><td>4.16 or 4.163</td><td>± 0.04</td></tr><tr><td>4.33 or 4.335</td><td>± 0.04</td></tr><tr><td>4.48 or 4.481</td><td>± 0.04</td></tr><tr><td>4.65 or 4.652</td><td>± 0.04</td></tr></table>Values of V correct as shown above.</td><td>1</td></tr>
<tr><td>Absolute uncertainties in V 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 V 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. Do not accept line from top point to bottom point. Points must be balanced. Line must pass between (27.5, 3.90) and (29.5, 3.90) **and** between (82.0, 4.60) and (84.0, 4.60).	**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(c)(iv)	*y*-intercept determined by substitution of correct point with consistent power of ten in *m* and *y* into $y = mx + c$.	**1**
	y-intercept of worst acceptable line determined by substitution into $y = mx + c$. uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line **or** uncertainty = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept) Do not accept ECF from false origin method.	**1**

Question	Answer	Marks
2(d)(i)	*Y* determined using gradient **and** *Y* and *Z* given to 2 or 3 significant figures. $Y = \frac{p \times \text{gradient}}{k} = 7.3188 \times 10^{27} \times \text{gradient}$	**1**
	Z determined using *y*-intercept **and** *Y* and *Z* given with SI units. $Z = \frac{p \times y\text{-intercept}}{Yk}$ **or** $Z = \frac{y\text{-intercept}}{\text{gradient}}$ Units: Y: no unit Z: °C	**1**
2(d)(ii)	Percentage uncertainty in *Y* with method shown. $\text{percentage uncertainty} = \left(\frac{\Delta p}{p} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$ **or** Correct substitution for max/min methods.	**1**

Question	Answer	Marks
2(e)	θ determined to a minimum of 2 significant figures from **(c)(iii)** and **(c)(iv)** or **(d)(i)** with correct substitution and correct powers of ten. $V = \frac{\pi \times (0.0279)^2 \times 0.0600}{4} = 3.67 \times 10^{-5}$ **and** $\theta = \frac{pV}{Yk} - Z$ **or** $\theta = \frac{V}{\text{gradient}} - Z$ **or** $\theta = \frac{V - y\text{-intercept}}{\text{gradient}}$ **or** using h directly: $\theta = \frac{p\pi d^2 h}{4Yk} - Z$ **or** $\theta = \frac{\pi d^2 h}{4 \times \text{gradient}} - Z$ **or** $\theta = \frac{\frac{\pi d^2 h}{4} - y\text{-intercept}}{\text{gradient}}$	**1**