Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2020**

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.

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Annotations

✓	Correct point Method of analysis marks in **Question 1**
✓$_{1–10}$	Additional detail marks in **Question 1**
X	Incorrect point
^	Omission
BOD	Benefit of the doubt
NBOD	No benefit of the doubt given
ECF	Error carried forward
P	Defining the problem marks in **Question 1** Power of ten error in **Question 2**
M0	Methods of data collection marks in **Question 1**

Question	Answer	Marks
1	**Defining the problem**	
	A is the independent variable and *x* is the dependent variable **or** vary *A* and measure *x*	**1**
	keep *m* constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • spring fixed at one end (to a support) • load attached to the other end • labelled load/mass	**1**
	clamped labelled ruler perpendicular by eye **and** ruler positioned close to the spring	**1**
	method to determine *x*: record initial position, record final position **and** subtraction **or** record length of stretched spring, original length of spring **and** subtraction	**1**
	use of a micrometer/calipers to determine diameter *d* of wire	**1**
	Method of Analysis	
	plots a graph of lg *x* against lg *A* or equivalent	**1**
	n = gradient **and** relationship valid if a straight line	**1**
	$\gamma = \dfrac{mgw^3N}{\rho \times 10^{y\text{-intercept}}}$	**1**

Question	Answer	Marks
1	**Additional detail including safety considerations**	**6**
	D1 use safety goggles/safety screen to prevent injury to eyes from (moving) spring/load **or** use cushion/sand box in case load falls	
	D2 keep constant all of: • *w* • *N* • ρ (or use same material for wire)	
	D3 measure mass of load/*m* with a balance **or** use newton meter to measure weight of load	
	D4 use ruler/calipers to measure the width of the spring/*w*	
	D5 use the equation ρ = mass of metal / volume to calculate ρ	
	D6 method to measure *w*, e.g. *w* measured to the outside and subtract *d* **or** method to measure ρ, e.g. mass (balance) and volume (measuring cylinder)	
	D7 repeat measurement of *x* (for the same *A*) and average	
	D8 repeat measurements of either *d* or *w* made in different places/directions and average	
	D9 use of $A = \pi d^2 / 4$ to determine *A* of wire	
	D10 use of set square to check that clamped ruler is vertical to bench **or** use of set square/pin as a fiducial mark to read positions (on the ruler)	

Question	Answer	Marks
2(a)	gradient = $\frac{1}{f}$ y-intercept = $\frac{t}{2f} - 1$	**1**
2(b)	$\frac{h_i}{h_o}$: 0.71 or 0.708; 0.79 or 0.792; 0.92 or 0.917; 1.1 or 1.08; 1.3 or 1.29; 1.5 or 1.50	**1**
	Absolute uncertainties in $\frac{h_i}{h_o}$ from ± 0.07 to ± 0.1 (or ± 0.10 or ± 0.11).	**1**
2(c)(i)	Six points plotted correctly. Must be accurate to nearest half a small square. Diameter of points must be less than half a small square.	**1**
	Error bars in $\frac{h_i}{h_o}$ plotted correctly. All error bars must be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.	**1**

Question	Answer	Marks
2(c)(ii)	Line of best fit drawn. Points must be balanced. Do not accept line from top to bottom point. Line must pass between (55, 0.75) and (56, 0.75) **and** between (77, 1.40) and (78, 1.40).	**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 at least half the length of the drawn line.	**1**
	Gradient of worst acceptable line determined. 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 from substitution into $y = mx + c$.	**1**
	y-intercept determined using gradient from worst acceptable line. 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) No ECF from false origin method.	**1**

Question	Answer	Marks
2(d)(i)	*f* determined using gradient with correct substitution shown. $f = \frac{1}{\text{gradient}} = \frac{1}{\textbf{(c)(iii)}}$	**1**
	f determined using gradient **and** given to two or three significant figures **and** correct SI unit shown with correct power of ten e.g. 33 cm or 0.33 m or 33.1 cm or 0.331 m	**1**
	Absolute uncertainty in *f* determined. absolute uncertainty in $f = \frac{\Delta\text{gradient}}{\text{gradient}} \times f$	**1**
2(d)(ii)	*t* determined using *y*-intercept **and** given to two or three significant figures. Correct substitution of numbers required. $t = 2f \times (y\text{-intercept} + 1)$ **or** $t = \frac{2 \times (y\text{-intercept} + 1)}{\text{gradient}}$	**1**