Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **March 2018**

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.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1	**Defining the problem**	
	d is the independent variable and *e* is the dependent variable, or vary *d* and measure *e.*	**1**
	Keep *F* constant.	**1**
	Methods of data collection	
	Labelled workable diagram including elastic cord fixed at one end to a support and load attached to the other end Cord and weight must be labelled	**1**
	Use of ruler to measure unstretched length and stretched length. or labelled ruler drawn parallel to cord and original length *L* and either *e* or stretched length indicated.	**1**
	Use of a micrometer / (calipers) to determine *d*.	**1**
	Weigh load on a balance or use of balance to measure mass of load and multiply by *g*	**1**
	Method of Analysis	
	Plots a graph of *e* against $1 / d^2$ or equivalent	**1**
	Relationship valid if a straight line passing through the origin is produced	**1**
	$E = \frac{4FL}{gradient \times \pi}$	**1**
	Additional detail including safety considerations	**Max 6**
	Use safety goggles / safety screen to prevent injury to eyes from (moving) elastic cord / load or use cushion / sand box in case load falls.	**D1**
	Keep *L* constant	**D2**
	Method to keep *L* constant, e.g. check length of each cord / adjust through cork	**D3**

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Question	Answer	Marks
1	Additional detail on measuring *e*, e.g. record initial position, record final position and subtract	**D4**
	Repeat measurement of *d* along cord / different diameters and average	**D5**
	Method to ensure Hooke's law is obeyed, e.g. check that the length is constant after removing load or do not exceed elastic limit	**D6**
	Wait for cord to extend to its maximum value / stop oscillating	**D7**
	Use of $A = \frac{\pi d^2}{4}$	**D8**
	Use of set square to check that ruler is vertical to bench, or use of set square as a fiducial mark to read measurements	**D9**

Question	Answer	Marks
2(a)	Gradient = $\frac{D}{S}$	**1**
2(b)	3.95 4.35 4.80 5.20 5.55 5.90	**1**
	Absolute uncertainties in $P \pm 0.05$	**1**

Question	Answer	Marks
2(c)(i)	Six points plotted correctly. Must be within half a small square. Diameter of points must be less than half a small square.	**1**
	Error bars in *P* plotted correctly. All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.	**1**
2(c)(ii)	Line of best fit drawn. Points must be balanced. Line must pass between (6.45, 5.8) and (6.55, 5.8) and between (4.55, 4.2) and (4.65, 4.2)	**1**
	Worst acceptable line drawn. Steepest or shallowest possible line that passes through all the error bars. Mark scored only if all error bars are 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 determined of WAL 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)(i)	Substitution of gradient to determine *s* $s = \frac{D}{\text{gradient}} = \frac{2.20}{\textbf{(c)(iii)}}$	**1**
	s determined using gradient, given to 2 or 3 significant figures	**1**
	s determined using gradient and correct unit and correct power of ten	**1**

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Question	Answer	Marks
2(d)(ii)	Percentage uncertainty in s %uncertainty in D + %uncertainty in gradient $\%s = \left(\frac{0.02}{2.20} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$ $\%s = 0.91 + \frac{\Delta\text{gradient}}{\text{gradient}} \times 100$ Or correct maximum/minimum method $\max s = \frac{\max D}{\min \text{gradient}}$ or $\min s = \frac{\min D}{\max \text{gradient}}$	**1**

Question	Answer	Marks
2(e)	Correct substitution of numbers must be seen, λ in the range 4.05×10^{-7} m to 4.24×10^{-7} m $\lambda = \dfrac{3.5\times10^{-3}}{\text{gradient}} = \dfrac{3.5\times10^{-3}}{\textbf{(c)(iii)}}$ OR $\lambda = 3.5\times10^{-3}\times\dfrac{s}{D} = 3.5\times10^{-3}\times\dfrac{\textbf{(d)(i)}}{2.2}$	**1**
	Correct substitution of numbers must be seen, Determines absolute uncertainty in λ. Using **(c)(iii)** $\text{uncertainty} = \left(\dfrac{0.05}{3.50} + \dfrac{\Delta\text{gradient}}{\text{gradient}}\right)\times\lambda$ or $\max\lambda = \dfrac{3.55\times10^{-3}}{\min\text{gradient}}$, or $\min\lambda = \dfrac{3.45\times10^{-3}}{\max\text{gradient}}$, OR Using **(d)** $\text{uncertainty} = \left(\dfrac{0.05}{3.50} + \dfrac{0.02}{2.20} + \dfrac{\textbf{(d)(i)}}{100}\right)\times\lambda$ $\text{uncertainty} = \left(0.0234 + \dfrac{\textbf{(d)(i)}}{100}\right)\times\lambda$ or $\max\lambda = \dfrac{3.55\times10^{-3}\times\max s}{2.18}$, or $\min\lambda = \dfrac{3.45\times10^{-3}\times\min s}{2.22}$.	**1**

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