CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 series

9702 PHYSICS

9702/53 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

1 Planning (15 marks)

Defining the problem (3 marks)

P λ is the independent variable or vary λ. [1]
P θ is the dependent variable or measure θ (for each λ). [1]
P Light sources to be of similar intensity/brightness. [1]

Methods of data collection (5 marks)

M1 Labelled diagram showing observer, light sources with method of producing monochromatic light e.g. filter/coloured LED. [1]
M2 Method to measure wavelength: record from filter/LED or Young's slit/diffraction grating method. [1]
M3 Use a rule to measure the distances. [1]
M4 Method to determine θ, e.g. θ (or sin θ or tan θ) = separation/distance or

$$\tan\left(\theta/2\right) = \frac{\text{separation}}{2 \times \text{distance}}$$

Do not allow protractor methods. [1]

M5 Carry out the experiment in a dark room. [1]

Method of analysis (2 marks)

A Plot a graph of θ against λ. [Allow lg θ against lg λ]. [1]
A Relationship valid if straight line <u>through origin</u>. [1]
[If lg-lg then straight line with gradient = (+)1 (ignore reference to *y*-intercept)]

Safety considerations (1 mark)

S Lamp becomes hot, therefore do not touch/switch off when not in use or use gloves when moving hot lamp.
OR Light may damage eyes, therefore wear dark glasses or do not look at unprotected lamps. [1]

Additional detail (4 marks)

D1/2/3/4 Relevant points might include [4]
1 Use vertical filament lamps. Allow vertical slits.
2 Additional detail on measuring λ e.g. use of equation for Young's slit/diffraction grating method.
3 Use of vernier calipers to measure the separation of light sources.
4 Use large distances/separations.
5 θ = sin θ = tan θ for small angles.
6 View with the same eye.
7 Method to ensure distances are perpendicular or observer <u>equidistant</u> from pair of lamps.
8 Repeat experiment for each λ <u>and</u> average.
Do not allow vague computer methods.

[Total: 15]

2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	Gradient = kA^2	
(b)	T1 T2	<table><tr><td>1.3 or 1.33</td><td>1.2</td></tr><tr><td>0.8(0)(0)(0)</td><td>0.74</td></tr><tr><td>0.571 or 0.5714</td><td>0.54 or 0.55</td></tr><tr><td>0.444 or 0.4444</td><td>0.41 or 0.411 or 0.410</td></tr><tr><td>0.364 or 0.3636</td><td>0.34</td></tr><tr><td>0.308 or 0.3077</td><td>0.29 or 0.30</td></tr></table>	T1 must be values in $1/M$. Ignore row 2. T2 must be to 2 s.f. or 3 s.f.
	U1	From ± 0.2 or ± 0.15 to ± 0.02 or ± 0.03	Allow more than one significant figure. Do not allow ± 0.1 for row 1.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Penalise 'blobs'. Ecf allowed from table.
	U2	All error bars in v^2 plotted correctly	Must be accurate within half a small square.
(c) (ii)	G2	Line of best fit	There must be a balance of points about the line of best fit – examiner judgement. Allow ecf from points plotted incorrectly.
	G3	Worst acceptable straight line. Steepest or shallowest possible line that passes through <u>all</u> the error bars.	Line should be clearly labelled or dashed. Should pass from top of top error bar to bottom of bottom error bar **or** bottom of top error bar to top of bottom error bar. Mark scored only if error bars are plotted.
(c) (iii)	C1	Gradient of best fit line	The triangle used should be at least half the length of the drawn line. Check the read offs. Work to half a small square. Do not penalise POT. Should be about 0.9.
	U3	Uncertainty in gradient	Method of determining absolute uncertainty. Difference in worst gradient and gradient.
(d) (i)	C2	k = gradient / A^2 = gradient / 0.04	Should be about 22.
	C3	N m^{-1}	Allow kg s^{-2}
(d) (ii)	U4	Percentage uncertainty in k	$\frac{\Delta m}{m} \times 100 + 2 \times \frac{\Delta A}{A} \times 100 = \frac{\Delta m}{m} \times 100 + 5\%$

(e)	C4	v in the range 0.534 to 0.559 and given to 2 or 3 s.f.	For 2 s.f. 0.53 to 0.56
	U5	Uncertainty in v	

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U3]
Uncertainty = gradient of line of best fit – gradient of worst acceptable line
Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(d) (ii) [U4]

Percentage uncertainty = $\frac{\Delta m}{m} \times 100 + 2 \times \frac{\Delta A}{A} \times 100 = \frac{\Delta m}{m} \times 100 + 5\%$

Maximum $k = \frac{\max m}{(\min A)^2}$

Minimum $k = \frac{\min m}{(\max A)^2}$

Percentage uncertainty = $\frac{\Delta k}{k} \times 100 = \frac{1}{2} \frac{(\max k - \min k)}{k} \times 100$

(e) [U5]

Percentage uncertainty = $\frac{\Delta A}{A} \times 100 + \frac{1}{2} \times \frac{\Delta k}{k} \times 100$

Absolute uncertainty = v × percentage uncertainty/100

Maximum $v = \max A \times \sqrt{\frac{\max k}{0.75}}$

Minimum $v = \min A \times \sqrt{\frac{\min k}{0.75}}$

Absolute uncertainty = max v – v or v – min v or $\frac{1}{2}(\max v - \min v)$