A-LEVEL

Physics

Investigative and Practical Skills in AS Physics – PHY3T/P15
Final Marking Guidelines

Specification 2450/2455
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Version/Stage: Final Marking Guidelines

Guidance for teachers marking Physics ISAs

The marking guidelines have been devised by a team of experienced examiners. They have tried to anticipate all possible responses worthy of credit. In order to establish consistency it is essential that all centres mark exactly to this scheme.

For ease of use the mark scheme has been presented in tabular form. Concise answers are given in the left-hand column. More detailed explanatory notes for some questions are included in the right-hand column.

Marking of Stage 1 of the ISA – student data and graph – should ideally be completed before the ISA written test to ensure that candidates do not change any data. (Alternatively, centres should take other steps to ensure that candidates do not change any information on their data script/graph). The marking of this section should be annotated with a red tick at the point where the mark has been awarded together with the letter referring to this mark scheme, eg '✓b'. **No other comments or feedback should be written on the candidates' scripts**. The total mark for this section should be written at the top of the paper. This will be transferred to the grid on the front page of the ISA test booklet.

Marking of the ISA test should be done using a red tick to represent each mark awarded. Further annotated comments **can** be added where necessary as an explanation as to why a particular point has been awarded which will greatly aid the moderation process. The total mark for each question should be entered on the grid on the front cover of the ISA booklet and the total mark calculated. Assessment Advisers are allocated to each centre and they can advise on the marking process. You should receive the contact details for the Assessment Advisor through the post. If you have not received them, please contact the AQA subject team.

Stage 1		Mark	Additional guidance notes
(a)	Table with column headings showing all recorded results derived quantities and correct units for <u>all</u> columns Must include a column for *m*, *h*, repeat values of *h* and *d*, mean value of *h* and *d* and the derived function $\left(1 - \frac{L}{d}\right) h$ **AND** *L* , with unit, recorded separately. Do not penalise if L is included in the table. ✓	1	Column headings can be either in words or standard symbols. Units can be in words or the correct abbreviation e.g. height/metres, *h*/m. Alternative acceptable labelling includes *h*(m), *h* in m etc. N.B. the unit of the function $\left(1 - \frac{L}{d}\right) h$ is mm, cm or m Do not award if any of units are in the body of the table.
(b)	Significant figures correct for all readings. ✓	1	Distances quoted to nearest mm Masses quoted to nearest g, ie 100 g or 0.100 kg No significant figure penalty for derived quantities.
(c)	Correct computation of mean values of h and *d,* **AND** Correct computation of the function $\left(1 - \frac{L}{d}\right) h$ Checked in the 1st and 3rd data lines ✓	1	The mark is only available if students have taken repeat readings (as instructed in the task sheet). The mark is awarded if the 1st and 3rd data lines are correct. No sf penalty on these values.
(d)	Suitably large graph scale (do not award if scale on axis could have been doubled) Scale must be sensible divisions which can be easily read, e.g. scales in multiples of 3, 6, 7, 9 etc are unsatisfactory. ✓	1	The plotted points should occupy at least half of each axis. N.B. A scale division in 4's might sometimes be acceptable.

Question		Mark	Additional marking guidance
(e)	Correctly labelled axes with units **AND** $\left(1 - \frac{L}{d}\right) h$ plotted on the *y*-axis ✓	1	Alternative method of labelling axes as in (a) above for table headings. Ecf for unit errors/omissions already penalised in (a), although a different error on either axis will incur a penalty.
(f)	Points accurately plotted to within 1mm. Check 1st and 3rd points from the *y*-axis, which must both be correctly plotted to award the mark.✓	1	This mark is independent of mark (e), i.e. if an unsuitable scale has been used, full marks can still be awarded for accurately plotting the points.
(g)	Straight line of best fit drawn ✓	1	The line of best fit should have an approximately equal distribution of points on either side of the line.
	Total	**7**	

Section A

Question		Mark	Additional marking guidance
1(a)	Mass / m✓	1	
1(b)(i)	Correct % uncertainty in L based on an uncertainty of $\pm$ 1 mm converted to a % value✓	1	No sf penalty
1(b)(ii)	This would normally be the % uncertainty in smallest value of d, calculated from the uncertainty in the mean value (from 0.5 x range) and converted to a percentage value✓	1	Although the smallest value of d would usually give the largest % uncertainty, allow calculation from an alternative value provided it gives the larger % uncertainty. If repeat readings of d are identical, uncertainty in d should be based on instrument precision of $\pm$ 1mm No sf penalty
1(b)(iii)	Correct calculation of % uncertainty in $\frac{L}{d}$ by adding % uncertainties in answers quoted from 1(b(i) and 1 (b)(ii)	1	Allow ecf from 1(b)(i) and 1(b)(ii) Answers to 1 or 2 sf only
1(c)(i)	Straight line with intercept means: Linear relationship / of the form $y=mx+c$ / increase in y proportional to increase in x ✓ **OR** Straight line through origin means relationship is (directly) proportional✓	1	
1(c)(ii)	$\left(1 - \frac{L}{d}\right) h = k_1 m + k_2$ where k_1 and k_2 are constants ✓	1	Allow credit for candidates who have correctly stated this in 1(c)(i) **Must** state that k_1 and k_2 are constants (any unambiguous symbols can be used instead of k_1 and k_2) Allow credit if the actual values of k_1 and k_2 have been calculated and have been included in the equation. **Where the straight line passes through the origin** the same formula without k_2 Where the straight line has been deliberately forced through the origin, the equation must still include the constant k_2

Question		Mark	Additional guidance notes
1(d)	• Moving boss B up and down the stand, wait until the beam is **stationary** ✓ • Check that it is horizontal by measuring from bench in at least two places, checking that readings are identical, and using **set square** to ensure ruler is vertical. ✓ • Assumes bench is horizontal ✓	3	Award credit for any of the marking points shown diagrammatically.
1(e)	• Retort stand not being vertical • Mass of cantilever (not included as part of mass *m*) • Bench not horizontal (since it is used as reference to get cantilever horizontal) Any 2 of above points ✓✓	2	Friction at nail excluded since this will vary each time
1(f)	• Random error in measured value of *h* due to cantilever not being adjusted to be perfectly horizontal ✓ because amount/direction of mis-adjustment would vary each time. ✓ • friction at pivot (nail) ✓ with explanation that it would be different for every reading. ✓ • Parallax error reading ruler for *h* or *d* ✓ since this will vary with each reading depending on angle at which ruler is viewed ✓ Any of above alternatives achieves one mark for naming the random error and a second mark for the 'matching' explanation ✓✓	2	Alternatives: There may be credit worthy answers re: beam bending or twisting , together with a suitable explanation OR Effect of the knot in the string tightening, causing the string to get longer.
	Total	**13**	

Section B		Mark	Additional guidance notes
2(a)	0.416 or 0.417 and 0.495 or 0.496	1	
2(b)	Both plotted points to nearest mm✓ Straight line of best fit ✓	2	The line should be a straight line with approximately an equal number of points on either side of the line.
2(c)	Large triangle drawn (at least 8cmx8cm) ✓ Correct values read from graph✓ Gradient value in range 0.805 to 0.837 to 2 or 3 sf ✓	3	
2(d)(i)	For showing correct vertical component of at least one of the forces/tensions as $mg\cos\theta$ or both vertical components as $2\ mg\cos\theta$ Question specifically referred to resolving forces so component must include g. ✓	1	
2(d)(ii)	$\cos\theta = \frac{d}{\text{hypotenuse}} = \frac{d}{\sqrt{(d^2+(x^2/4))}}$ ✓ $\frac{d}{\sqrt{(d^2+(x^2/4))}} = \frac{M}{2m}$ compared to $y = mx$ ✓ (Hence gradient is $\frac{1}{2m}$)	2	
2(d)(iii)	Magnitude of m correct from $\frac{1}{2 \times \text{their gradient from 2(c)}}$ ✓ kg and 2 or 3 sf ✓	2	e.g middle gradient value gives m = 0.609 kg Allow ecf from gradient value. Sf and unit mark depends on correct calculation of m from the gradient value.

Question		Mark	Additional guidance notes
2(e)(i)	Friction at the pulleys ✓	1	
2(e)(ii)	Take a mean value of readings from loading and unloading. ✓	1	
	Total	**13**	

Question		Mark	Additional guidance notes
3(a)	Description of technique : Use small plane mirror beneath string/use of set square/bright light source to project shadow of the strings onto the paper, and marking points on shadow to aid drawing lines ✓ Explanation: Line of sight not perpendicular from string to paper/ mark on paper depends on the angle the eye is positioned at/reference to parallax error. ✓	2	
3(b)(i)	Value of θ quoted as 30^o or 31^o (for a protractor with precision $\pm 1^o$) OR θ = 30.0, 30.5, 31.0 (for a protractor with precision $\pm$ 0.5^o) ✓ Correct computation of % uncertainty, answer quoted to 2 or 1sf ✓ Extra mark for a candidate who measures the angle 2θ (rather than just the single angle θ) ✓ (This 3rd mark can also be awarded for a candidate who has measured θ on both sides of the 'vertical line', and taken the mean value)	3	Markers should measure the angle to check that no scaling error has been introduced in the photocopying of the paper. If the angle is different, mark accordingly. Answers should be consistent with protractor precision stated by the candidate. Allow ecf for incorrect angle (penalised in 1st marking point). (eg if using a protractor with 1^o precision % uncertainty will be 1/31 x 100% = 3.2% or 3% OR for candidates who measured the angle 2θ % uncertainty = 1/62 x 100 = 1.6% or 2%. With a protractor with precision $\pm$ 0.5^o the % uncertainties will be half these values) This is because the question specifically stated "as accurately as possible". It should be clear from the candidate's percentage uncertainty calculation whether 2θ or θ has been measured.

Question		Mark	Additional guidance notes
3(b)(ii)	Evidence of right angled triangle drawn on to the diagram with dimensions of two sides also shown on the diagram. The minimum dimension shown must be 70mm. ✓ Angle correctly computed using sine cosine or tangent, with value quoted in the range 30.0^{o} to 31.4^{o} ✓	2	Correct use of cosine rule without right angled triangle is acceptable. Angle quoted to 3 sf/to 0.1^{o} 2^{nd} mark is still available to a candidate who didn't achieve the 1^{st} mark.
3(c)	Plot a graph of $\cos\theta$ against $1/m$ AND Statement that it should give a straight line through origin ✓	1	Allow graphs of $1/m$ **against** $\cos\theta$, m against $1/\cos\theta$ and $1/\cos\theta$ against m, which would all be straight lines through the origin.
	Total	**8**	
	ISA Total	**41**	