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General Certificate of Education (A-level)
June 2013

Physics

Investigative Skills Assignment (ISA P)

PHY3/P13/mark

Written Test

Final Marking Guidelines

Set and published by the Assessment and Qualifications Alliance.

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Marking Guidelines Explanatory Notes

The marking guidelines should be considered a working document. A version of the marking guidelines will be placed on the Secure Key Materials Website in September. This is to allow centre's to undertake ISA practicals as soon as they wish. Centres can use this version of the marking guidelines to mark candidates work. However this version of the marking guidelines may be subject to amendments. An updated version of the marking guidelines to be used during the present academic year will be placed on the Secure Key Materials Website by **31st October**. Examinations Officers must ensure that Teachers receive the final version of the marking guidelines. **Centres should ensure that their marking is in line with the updated version of the marking guidelines**.

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.

ISA (P) Forces in Equilibrium

Stage 1		Mark	Additional guidance notes
(a)	Single clear table with columns correctly headed with both quantity and unit ✓	**1**	Headings can be in words or symbols. Units can be in words or the correct abbreviation. Standard notation for quantity and unit is expected e.g. $\frac{M}{\cos\left(\frac{\theta_m}{2}\right)} / \text{kg}$ but accept units given inside brackets e.g. $\frac{M}{\cos\left(\frac{\theta_m}{2}\right)}\ (\text{g})$ *Do **not** award this mark if any units are written in the body of the table*
(b)	Six completed rows of data for M = 100, 200, 300, 400, 500 and 600 g. Each row must have four recorded values for length and two for angle θ. ✓	**1**	All values M should be given to the nearest gram. However allow 0.10 kg, etc but **do not** allow 0.1 kg, etc. All values of length must be given to the nearest mm and all values of θ to the nearest degree only.
(c)	Values of L and θ_m correctly calculated for M = 200 g and M = 400 g (i.e. 2nd and 4th readings).✓	**1**	No sf penalty
(d)	$\frac{M}{\cos\left(\frac{\theta_m}{2}\right)}$ correctly calculated for M = 200 g and M = 400 g.✓	**1**	No sf penalty but allow ecf from (c)
(e)	Suitably large graph scale (do not award if scale on either axis could have been doubled). Scale must have sensible divisions which can be easily read (e.g. not in multiples of 3, 6, 7, 9 etc.) and both scales must start at zero✓	**1**	The plotted points *plus the origin* should occupy at least half of each axis.

ISA (P) Forces in Equilibrium

(f)	*L* plotted on the *y-axis* and $\frac{M}{\cos\left(\frac{\theta_m}{2}\right)}$ on the *x-axis* with both axes correctly labelled with quantity and unit✓	**1**	Allow error carried forward for incorrect unit(s) from the table, but otherwise **no unit: no mark**. *However, do not penalise here if the unit is missing both on the graph and in the table.*
(g)	**First** and **fifth** points from the *y*-axis accurately plotted to within 1 mm✓	**1**	This mark is independent of mark (e), i.e. candidates who have used an unsuitable scale can still achieve the mark for accurate plotting.
(h)	Suitable straight line of best fit drawn✓	**1**	A straight line with a positive gradient and a positive intercept on the *L* axis is expected, but credit any well drawn straight line that fits the trend and cuts the *L* axis if there is an even scatter of points about the line Points which are obviously anomalous should not unduly influence the line drawn.
	Total	**8**	

ISA (P) Forces in Equilibrium

Stage 2 Section A		Mark	Additional guidance notes
1(a)(i)	Graph supports prediction because: Graph has a positive gradient✓ Graph has a positive intercept on the L-axis (or y-axis) ✓ **OR** Graph does not support prediction because: Graph is not a straight line **or** graph does not have a positive gradient **or** graph does not have a positive intercept on the L-axis	**2**	**One mark only** can be awarded for the explanation if the graph does not support the theory.
1(a)(ii)	Answer is reliable because the points are close to the line of best fit✓ **OR** Answer is not reliable because (some of) the points are not very close to the line of best fit	**1**	
1(a)(iii)	Value of B correctly found from intercept on the *L*-axis: value (probably between 4 and 6 cm)✓ 2 or 3 sf with unit✓	**2**	
1(a)(iv)	Length of spring when $M = 0$ ✓	**1**	Accept: the unstretched/original/natural length of the spring
1(b)(i)	Half the range **or** ± 1 mm if all values the same✓	**1**	Allow missing ± but a correct unit is required No sf penalty
1(b)(ii)	Half the range **or** ± 1 degree if all values the same✓	**1**	Allow missing ± No sf or unit penalty
1(b)(iii)	Both percentage uncertainties shown correctly calculated, together with a correct statement as to which is the larger (or if they are the same, a statement to that effect)✓	**1**	Allow ecf from (b)(i) and/or (b)(ii)

1(b)(iv)	Statements to the effect that: % uncertainty in L is smaller with the larger mass✓ % uncertainty in θ_m is greater with the larger mass✓ Consistent conclusion ✓	**3**	*Consistent conclusion:* **If** in part (b)(iii) $\delta L\%$ < or = $\delta\theta_m\%$ **then** the difference would increase and $\delta\theta_m\%$ would (still) be the larger **If** in part (b)(iii) $\delta L\%$ > $\delta\theta_m\%$ **then** it is likely that $\delta\theta_m\%$ would now be larger than $\delta L\%$
	Total	**12**	

ISA (P) Forces in Equilibrium

Stage 2 Section B		Mark	Additional guidance notes
2(a)(i)	W = 2*mg* cosϕ $\quad \therefore$ *m* = W/(2*g* cosϕ)✓	**1**	The question says *show that,* so the candidates must write down both steps.
2(a)(ii)	2.411 ✓ | 0.793 ✓ 2.635 | 0.856	**2**	One mark for each column: exact answers only.
2(a)(iii)	Both points correctly plotted to the nearest mm✓ Well drawn straight line of best fit.✓	**2**	The line should follow the trend of the points with an even scatter of points on either side of the line.
2(b)(i)	Triangle drawn with smallest side at least 8 cm in length. ✓ Correct readings taken from the line for the triangle ✓ Gradient in the range 0.45 to 0.49 (0.445 to 0.494) quoted to 2 or 3 significant figures ✓	**3**	The size of the triangle can be identified from readings taken from the line. The third mark is independent of the other two: error carried forward for incorrect readings (or for a poor line of best fit) which give a gradient out of range is not allowed.
2(b)(ii)	Candidate's answer for gradient in 2(b)(i) correctly multiplied by *g* (expected answer 4.6)✓ N ✓	**2**	No s.f. penalty. The second mark is for the unit and can be awarded if the numerical answer is incorrect.
2(c)	δx% = 0.2 and δy% = 0.5✓ $\delta(x/y)$% = δx% + δy% = 0.2 + 0.5 = 0.7 ✓ Use of $\delta(x/y)^2$% = 2 x $\delta(x/y)$(%) ✓	**3**	Final answer is ($\pm$) 1.4 (%) which automatically gains all three marks **Otherwise** Accept only 1 s.f. for 1st and/or 2nd marks. The third mark is for the method, not the final answer

2(d)(i)	Systematic errors in measurements are errors which show a pattern or a bias or a trend ✓	**1**	*Some acceptable alternatives* • A systematic error is one which deviates by a fixed amount from the true value of a measurement • An error which has the same value in all readings • A difference between the true value of a quantity and the indicated value caused by a fault in the measuring device • Accept a good example of systematic error.
2(d)(ii)	*y* would be larger✓ because angle θ would be smaller **or** because friction would be opposing the increasing weight of *m*✓	**2**	
	Total	**16**	

ISA (P) Forces in Equilibrium

Stage 2 Section B		Mark	Additional guidance notes
3	(a) Weigh the box and its contents <u>each time</u> (b) (With $\theta = 0$) place the box on the slope and lift the end slowly until the box is just about to slide down the slope and measure angle θ. (c) Measure angle θ <u>with a protractor</u>. **or** Determine angle θ using <u>trigonometry</u>. (d) take <u>at least three</u> readings for θ for each value of *W* and <u>then average them.</u> (e) Repeat step (b) <u>at least four</u> more times with a larger weight inside the box each time. (f) Plot a graph of θ (or tanθ) against *W*. (h) Award this mark for good practical technique ✓✓✓✓✓ 5 marks max	**5**	***Please note, next to your tick, put the letter corresponding to the marking point being awarded (e.g. ✓a).*** *Some acceptable answers for mark (h)* • With the box in the same position as before, repeat step (b) • Distribute the extra weight evenly inside the box • Raise the ramp with a lab-jack for stability/to measure θ accurately • Clamp slope when θ found before measuring it
	Total	**5**	