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General Certificate of Education (A-level)
June 2013

Physics

Investigative Skills Assignment (ISA Q)

PHY6T/Q13/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 (Q) Damped SHM

Stage 1		Mark	Additional guidance notes
(a)	Table with column headings showing all recorded results and correct units ✓ Must include columns for number of oscillations, *A,* ln(*A*/mm) and *t.* Readings for time period measurements should also be given – these will most likely be separate to the table.	**1**	Column headings can be either in words or standard symbols. Units can be in words or the correct abbreviation, eg time/seconds, *t*/s. Alternative acceptable labelling includes time(s), time in s etc. Do not award if any of units are in the body of the table. Accept $\log_e$ instead of ln
(b)	Significant figures correct for all readings ✓	**1**	Distances quoted to nearest mm, timings quoted to precision of stopclock. 'Readings' refers to raw data, not 'derived data' such as mean values, ln values etc.
(c)	At least 1 repeat reading for the time period, *T* and at least 1 repeat reading of amplitude ✓	**1**	Eg records time for at least 10 oscillations and shows at least one repeat (if a candidate times T/2 instead of T penalise this mark).
(d)	Correct computation of *t* **and** Correct computation of mean amplitude and in (*A*/mm) ✓ Check the 2nd and 4th data lines	**1**	The mark is awarded if the 2nd and 4th data lines are correct. No sig fig penalty on these values.
(e)	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. Eg scales in multiples of 3, 6, 7, 9 etc are unsatisfactory.	**1**	The plotted points should occupy at least half of each axis.
(f)	Graph correctly labelled axes with units ✓	**1**	Alternative method of labelling axes as in (a) above for table headings. Allow ecf for labels and units already penalised in (a).
(g)	Points accurately plotted to within 1mm. Check 1st and 5th points from the y-axis, which must both be correctly plotted to award the mark. Line of best fit drawn ✓	**1**	This mark is independent of mark (e), ie if candidates have used an unsuitable scale they can still achieve marks for accurately plotting the points. The line of best fit should have an approximately equal distribution of points on either side of the line.
	Total	**7**	

ISA (Q) Damped SHM

Section A		Mark	Additional guidance notes
1(a)	Number of oscillations or elapsed time ✓	**1**	
1(b)	Difficulty in judging stationary point of ball/parallax error ✓	**1**	
1(c)	• timing more oscillations • light gate and electronic timer/motion sensor and data logger/video with timing device. • use of fiducial marker at centre of oscillation • shielding from draughts • countdown procedure Any two of above ✓✓	**2**	Do not accept 'human error".
1(d)	Calculated by uncertainty in T, based on spread of repeat readings, and then converted to a % by: $\%\ \text{uncertainty} = \frac{\text{uncertainty}}{T} \times 100$ ✓	**1**	No sf penalty. No penalty for omitting ± or % sign. No mark available if repeat values were not taken.
1(e)(i)	(Take logs so) $\ln A = \ln A_0 - \lambda t$ ✓ $a = \ln A_0$ and $b = -\lambda$ ✓	**2**	

1(e)(ii)	$-\lambda$ ✓ (or *b* allowed if correct in (e)(i))	**1**	Award a mark to any candidate <u>who drew a curve through a curved trend in Stage 1</u> and answers **either** $-\lambda$ / *b* (as specified) **or** gives a valid comment that addresses the difference between the Stage 1 results and the prediction made in the stem of question 1. Eg 'My graph is curved so the theory does not describe my gradient' OWTTE / 'Cannot represent λ as gradient is not constant' **or** gives valid interpretation of gradient in context of the candidate's results 'Gradient is a measure of how fast the amplitude decreases with time' / 'Gradient is predicted to be ln λ'
1(e)(iii)	ln A_0 ✓ (or *a* allowed if correct in (e)(i))	**1**	Also allow ln(200/mm) but not value calculated. Also allow *a* and *b* for (ii) and (iii) for <u>1 mark total</u> where *a* and *b* not correctly identified in (e)(i) Award mark for correct answer that arises from a Stage 1 graph whether straight or curved.
1(e)(iv)	• points lie close to a straight line (or not) • value of ln A_0 close to intercept on graph • graph is a straight line with a negative gradient • comments on spread of results/uncertainty in readings ✓✓✓3 marks max	**3**	Where candidates have drawn a smooth curve for their stage 1 graph, credit can be achieved for the following marking points, allowing access to 3 marks:- • Graph is a curve/not a straight line, so does not fit predicted theory • Spread of results too great to justify having drawn a straight line / points plotted fit close to the smooth curve drawn • Reference to the fact that had they decided to draw a straight line instead of a curve it would have had a <u>negative gradient.</u>

1(f)	• Greater *T*, hence smaller % uncertainty ✓ • Easier to judge position of amplitude ✓, hence less spread of repeats/smaller uncertainty in amplitude measurements ✓	**3**	Allow less uncertainty in *A* values because *A* values larger or greater uncertainty because *A* values smaller ✓ Comments related to mass of string compared to mass of table tennis ball causing bending of string and error in timing - allow 1 mark.
	Total	**15**	

ISA (Q) Damped SHM

Section B		Mark	Additional guidance notes
2(a)	correct average $t_{1/2}$ values: 31.2, 38.0 correct log $t_{1/2}$ values: 1.494 (or 1.495), 1.580 correct log λ values: –1.654, –1.740 ✓	**1**	Exact values only (NB log values quoted are not 4sf the '1' is the mantissa of the log and not part of the sf)
2(b)	Both plotted points to nearest mm ✓ Best line of fit to points ✓	**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 8cm × 8cm) **and** Correct values read from graph ✓ Correct numerical answer for gradient = (-) 0.96 to 1.04 ✓ Negative sign included <u>and</u> value quoted to 2 or 3 sf ✓	 **1** **1** **1**	 Missing negative sign penalised on 3rd mark
2(d)	Recognises that gradient is –1 ✓ Indicates that $\lambda t_{1/2}$= constant **Or** λ inversely proportional to $t_{1/2}$ **Or** λ is proportional $(t_{1/2})^{-1}$ ✓	**2**	i.e. do not award first mark for +1. Allow ecf for 2nd mark for use of +1 for gradient value.
	Total	**8**	

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Question 3		Mark	Additional guidance notes
3	Determination of $t_{1/2}$ from graph by reading horizontally from half initial value of *A* to curve and vertically down to find $t_{1/2}$ ✓ Determination of 2nd value for $t_{1/2}$ from graph ✓ Value of $t_{1/2}$ from 9.8 to 10.85 **with** 2or 3 sf **and** correct unit Value must be correctly computed from a minimum of 2 values ✓	**3**	
	Total	**3**	

Question 4		Mark	Additional guidance notes
4(a)	0.2 s✓ (half the spread) % Uncertainty = $\frac{0.20\ x\ 100}{38.0}$ = ± 0.53 ✓	**2**	No sf penalty. No penalty for omission of ±. No penalty for omission of % sign.
4(b)	0.2 + 0.53 = 0.73(%) to 1 or 2 sf ✓	**1**	No penalty for omission of % sign.
	Total	**3**	

ISA (Q) Damped SHM

Question 5		Mark	Additional guidance notes
5	(a) Method for measuring amplitude (eg marking positions on track and measuring horizontal displacement with metre ruler) Use camera on <u>open shutter</u> OR video must include scale. (b) Method for measuring elapsed time for each corresponding amplitude measurement. (c) Release method to ensure initial velocity is zero. (d) Suggesting measuring at least 6 different amplitude measurements and corresponding elapsed time (e) Repeat readings of time and amplitude to reduce random errors (f) Plotting suitable graph (A-t or ln$A$-t) (g) How to interpret if graph shows an exponential decrease in amplitude ✓✓✓✓✓5 marks max	**5**	**Indicate the letter corresponding to the marking point awarded (e.g. ✓a).**
	Total	**5**	