General Certificate of Education

Physics

Investigative Skills Assignment (ISA) P

PHY6T/P10/mark
Written Test

Marking Guidelines

2010 examination – June series

WMP/Jun10/PHY6T/P10/mark

Marking Guidelines Explanatory Notes

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, e.g. '✓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 marks for each question should be entered on the grid on the front cover of the ISA booklet and the total mark calculated.

Further guidance and information about the marking guidelines will be given at the teacher support meetings which will be held in the later half of autumn 2010. Assessment Advisers are also allocated to each centre and they can advise on the marking process.

ISA (P) Simple Harmonic Motion (SHM)

Stage 1		Mark	Additional guidance notes
(a)	Table with column headings showing all recorded results for distance and time period with **all** units for raw data correct in column headings.	**1**	Column headings can be either in words or standard symbols. Units can be in words or the correct abbreviation, e.g. time/seconds, T/s. Alternative acceptable labelling includes time(s), distance in m etc.
(b)	Decimal places correct for all readings, compatible with precision of instruments for both timing and distance measurement.	**1**	e.g. distances quoted to nearest mm e.g. 0.600 m and timings compatible with precision of stopclock.
(c)	Evidence that candidate has timed full oscillation rather than 'half oscillation' (If candidate has timed half oscillations, penalise here but no further penalty on marking points below)	**1**	e.g. data check: Time period for full oscillation when s = 60.0 cm and d = 10.0 cm is 1.6 s.
(d)	Evidence of timing multiple oscillations (at least 10) **with** at least one repeat of multiple oscillations.	**1**	e.g. records time for 10 oscillations (or 20 oscillations) etc. and shows at least one repeat.
(e)	Tabulated data showing mean value of T. Sig figs must **not** be greater than precision of stopclock.	**1**	Two calculations should be checked, focusing on any suspect data.
(f)	Evidence of timings for at least **seven** different values of d covering a minimum range from 0.100 to 0.700 m.	**1**	
(g)	Suitably large graph scale (do not award if scale on either axis could have been doubled). Scale must be 'sensible' divisions which can be easily read. e.g. scales in multiples of 3, 4, 6, 7, 9, etc. are unlikely to be satisfactory. Axes must be labelled with quantity and unit T/s and d/m.	**1**	The plotted points should occupy at least half of each axis. Alternative method of labelling axes as in (a) above for table headings and units, e.g. time (seconds) etc. Do not award mark if T is plotted on x-axis.

(h)	Most points accurately plotted to within 1 mm (no more than one point > ± 1 mm) and curve of best fit drawn. **1**		This mark is independent of mark (g), i.e. if candidates have used an unsuitable scale they can still achieve marks for accurately plotting the points. Markers should check a proportion of plotted points. 'Most points' would typically allow one incorrect plot in a sample of 7 plotted points. The line should be a smooth curve to award the mark.
	Total	**8**	

Section A		**Mark**	**Additional guidance notes**
Question 1			
1 (a)	Time period. Accept time. ✓	**1**	
1 (b)	Fiducial marker (or reference marker) placed at centre of oscillations ✓ Pendulum bob is moving fastest at this point / Judging time at which bob is in this position is likely to have a smaller random error ✓	**2**	or position shown by sketch or diagram
1 (c)	Timing of multiple oscillations ✓ Reduces error in timing because larger total time recorded gives smaller percentage error / Reduces % error due to experimenter's reaction time. ✓	**2**	Alternative procedures – 1 mark for procedure and 1 mark for explanation: • Allow transient oscillations to die down before starting timing ✓ might be some 'variation' in time period for these transient oscillations ✓ • Ensure oscillations are small amplitude ✓ Large amplitude oscillations – time period will vary / not SHM ✓ • Use 'count down' technique for starting timing ✓ Difficult to start stopclock and release pendulum at same time, resulting in increased error / if releasing pendulum and starting stopclock timing would not be possible from centre of oscillation ✓

Question 1			
1 (d) (i)	Mark may be awarded for correctly squaring T^2 to obtain expression below as an intermediate step, **and** an attempt to substitute for L^2 from expression given in question. $T^4 = \frac{16\pi^4 L^2}{g^2}$ and attempt to substitute for T^2 ✓		
1 (d) (ii)	T^4 against d^2 / T^4 versus d^2 / T^4 on y-axis d^2 on x-axis ✓	**2**	Allow axes reversed, which still gives a straight line e.g. d^2 against T^4
1 (d) (iii)	Either from gradient: $g = -\frac{2\pi^2}{\sqrt{(Gradient)}}$ Or from intercept: $g = -\frac{4\pi^2 s}{\sqrt{(Intercept)}}$ ✓	**1**	May be explained in 'words' e.g. gradient negative / or numerically equal to $2\pi^2$ divided by square root of gradient.
	Total	**8**	

Section B		Mark	Additional Guidance Notes
Question 2			
2 (a) (i)	Miscounted the number of oscillations ✓ (difference between other two results is approx one time period).		Also accept equivalent explanations e.g. counted 19 instead of 20 oscillations/miscounted by 1 etc.
2 (a) (ii)	Repeat suspected anomalous reading ✓		Also allow: compute mean from other two results.
2 (a) (iii)	1.36 s ✓ (calculated from mean of two readings, ignoring anomalous timing) no unit penalty. Must be to 3 sf.	**3**	

2 (b)	Mean time period, T: 2.70, 4.04 s ✓ Log (T/s): 0.431, 0.606 ✓ Log (d/cm): –0.523, –0.699 ✓	**2**	No significant figure penalty – This same point was penalised for data in Stage 1. No unit penalty (units in table). No sig fig penalty. No sig fig penalty.
2 (c)	Both plotted points correctly plotted to within ± 1 mm or less from exact position ✓ Correct line of best fit ✓	**2**	The line must be a straight line (as instructed), with approximately an equal number of points on either side of the line.
2 (d)	Triangle drawn with smallest side at least 8 cm ✓ Correct values read from graph ✓ Correct answer for gradient: –1.01 ± 0.04 ✓	**3**	Penalise here for missing negative value of gradient. No ecf from incorrectly read values unless with limits stated.
2 (e)	Recognition that gradient gives 'power' of 'd' in equation ✓ An understanding that integral value from the gradient is –1 ✓ (integral value must be referred to as 1 not 1.0)	**2**	Algebraic explanation, by assuming equation to be of form $T = kd^n$, where n is the integral value of the gradient is acceptable. Still allow if integral value is stated as 1 (rather than –1), since a mark has already been awarded for negative value of gradient.
	Total	**12**	

Question 3		Mark	Additional Guidance Notes
3 (a)	k = 0.81 or 0.808 ✓ Unit of k is: ms or sm ✓	 **2**	Answer to 2 or 3 significant figures only.
3 (b) (i)	Mark for uncertainty in time based on spread of repeat timings: Uncertainty = ±0.2 (or 0.18) s ✓ (Calculated from uncertainty = ±(0.5 × spread repeats) = ± 0.5 × 0.36 s) Mark for correct value of % uncertainty = ±0.8% allow ecf (from: % uncertainty = $\frac{0.5 \times \text{spread repeats} \times 100}{\text{Mean time for oscillations}}$)	 **2**	Details of calculation not required. Marks can be awarded for correct numerical answers. No unit penalty in intermediate stage of calculation (e.g. 's' missing). Also no penalty for quoting uncertainty without '±'. Award this mark provided uncertainty in T is quoted at some point in calculations.
3 (b) (ii)	% uncertainty in d = $\frac{0.001 \times 100}{0.800}$ = ± 0.1% ✓	 **1**	No sig fig penalty on uncertainty values. Award if % or ± missing on answer. No sig fig penalty. Award if '±' is omitted.
3 (b) (iii)	Overall % uncertainty in value k = 0.8 + 0.1 = ±0.9% ✓ k = 0.81 ± 0.01 s m Allow ecf from 3 (b) (i) and 3 (b) (ii)	 **2**	No unit penalty. Uncertainty in k **must be shown as '±' value**. No unit or sig fig penalty.
	Total	**7**	

Question 4		Mark	Additional Guidance Notes
4 (a)	Time Period = 1.02 s ✓	**1**	No sig fig penalty. No penalty for omission of unit.
4 (b)	Marking points: • Electronic method Use of correct data in calc: $\%\ \text{uncertainty} = \frac{0.01 \times 100}{0.51}$ • Arrives at correct value for % uncertainty by electronic method = ± 2% (no sig fig penalty) • For **similar time period** 'manual method' 3 (a) (ii) above uncertainty = ± 0.8% • Hence 'manual method' better/less uncertainty in this situation ✓✓✓ **3 marks max**	**3**	No sig fig penalty in calculations or no penalty for omission of '±' values in uncertainty calcs. Allow ecf from 3 (a) (ii) if figures suggest electronic method better. If student does not include numerical comparison of uncertainties to justify most accurate method, then up to **1 mark** can be awarded for: • Recognising that electronic method may not necessarily be better than manually operated stopclock ✓ **No credit** for stating electronic method is better without any justification. (This is incorrect from data in question).
4 (c)	Electronic method could be improved by altering it so that it times multiple oscillations / Suggests electronic method could be improved by altering switching of electronic clock to time greater intervals than half an oscillation. ✓ Explanation: Timing (for a longer period) would give a smaller % uncertainty for same precision. ✓	**2**	
	Total	**6**	
	Total	**33**	