General Certificate of Education

Physics

Investigative Skills Assignment (ISA) P

PHY6T/P11/mark
Written Test

Final Marking Guidelines

2011 examination – June series

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 centres to undertake ISA practical's 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**. Examination 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.

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 also advise on the marking process.

Changes from the previous version are side barred on the appropriate side of the marking grid.

ISA (P) Oscillations of a spring

Stage 1		Mark	Additional guidance notes
(a)	Table with column headings showing all recorded values for m, times for multiple oscillations and mean time period T. **All** units correct **only** in column headings. ✓	**1**	Column headings can be either in words or standard symbols. Units can be in words or the correct abbreviation eg m/kilograms, m/kg, m/g. Alternative acceptable labelling includes m(kg), m in kg etc
(b)	Decimal places correct for all readings, compatible with precision of instrument used. (Ignore decimal places for processed data) ✓	**1**	eg mass quoted to nearest gram. Times quoted to precision of stopclock ie 0.01 s
(c)	At least one repeat reading for multiple oscillation timings for every value of m, with corresponding mean value of T calculated ✓	**1**	Check at least 2 mean values, focusing on any suspect data and indicating the data checked Check the 2nd and last mean value of T
(d)	Tabulated values of T^2 including unit, s^2 ✓	**1**	No sf penalty
(e)	Evidence that full oscillations have been timed, as opposed to 'half oscillations' **and** minimum number of 10 full oscillations timed ✓	**1**	Centres will be able to tell from timings depending on the spring constant of the spring used
(f)	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) Eg Scales with 3, 4, 6, 7, 9 divisions are unacceptable. Correctly labelled axes with units ✓ (T^2 must be on the vertical axis)	**1**	Both axes labelled with quantity and unit. Words or symbols may be used for physical quantities and units eg mass/kg, m/kg, m/g. Acceptable alternative labelling includes m (kg), m in kg Allow ecf from (d) if unit of T^2 is incorrect or missing

(g)	Most points accurately plotted to within 1 mm (no more than one point > ± 1 mm) ✓ Assessed by checking the 2nd and 3rd point from the origin.	**1**	This mark is independent of mark (f), ie if candidates have used an unsuitable scale they can still achieve marks for accurately plotting the points.
(h)	Line of best fit drawn ✓	**1**	The line should be a straight line with approximately an equal number of points on either side of the line. Points which are obviously anomalous should not unduly influence the line.
	Total	**8**	

Section A		Mark	Additional guidance notes
1(a)	Measure from bench to ruler at <u>both ends/in several positions</u>. Use set-square to adjust spring perpendicular to ruler ✓ **Or** Use of spirit level for ruler and set-square for spring (or spirit level for both ruler and spring)	**1**	Must include both ruler and spring Also allow use of plumbline for spring.

1(b)	Technique: timing multiple oscillations ✓ Explanation: reduce percentage uncertainty in timing ✓ Technique: use of fiducial marker at centre of oscillation ✓ Explanation: precisely identifies beginning/end of oscillation/travelling fastest at centre making it easier to identify exact time at which spring passes marker ✓	**4**	Alternative technique and explanation for 2 marks each • Technique: Ensure oscillations are small amplitude ✓ Large amplitude oscillations – time period will vary/not SHM ✓ • Allow transient oscillations to die down before starting timing ✓ might be some variation in time period for these transient oscillations ✓ • Use 'count down' technique for starting timing ✓ Difficult to start stopclock and release pendulum at same time, resulting in increased error/releasing pendulum and starting stopclock timing would not be possible from centre of oscillation ✓ Do not accept 'take more repeat readings'.
1(c)	Straight line graph but not through origin / the graph is linear but not directly proportional ✓ Increase in T^2 proportional to increase in m / suggests a relationship of the form $T^2 = km + c$ ✓	**2**	Do not allow directly proportional as the graph does not go through the origin Allow 1 mark max. as ecf for student who has produced a curved graph and makes a suitable comment Allow 1 mark max. for student whose line goes through the origin, for statement that quantities are directly proportional
1(d)	Consistent repeats confirming reliability / points close to line of best fit confirming reliability ✓	**1**	Just stating it is reliable because they did repeats is not enough. They must make it clear repeat readings are consistent or close
1(e)	Intercept on y axis at greater value ✓ Reference to gradient being same ✓	**2**	Allow reference to possible slight change in gradient for 2nd mark
	Total	**10**	

ISA (P) Oscillations of a spring

Section B		Mark	Additional Guidance Notes
Question 2			
2(a)	Mean t 15.70, 16.60 Mean T: 0.785, 0.830 ✓ Log (T/s): –0.105, –0.081 log(x/m): –0.097, –0.046 ✓	**2**	(NB Uncertainty of approx 1% in T values justifies / requires quoting T to 3 sf) Must have sf consistent with other data in column
2(b)	Both points plotted to nearest mm ✓ Line of best fit drawn through points ✓	**2**	Criteria for line of best fit same as Stage 1.
2(c)	Triangle drawn with smallest side at least 8 cm ✓ (or 8 grid square) correct values read from graph ✓ correct answer for gradient 0.47 ± 0.02 ✓	**3**	No ecf from reading incorrect data No unit penalty (There should be no unit, but no penalty if candidate incorrectly puts a unit) To 2 or 3 sf only. Value of gradient must be within stated range.
2(d)	Formula suggests $T \propto x^{1/2}$ or suggests $T \propto x^{\text{gradient}}$ ✓ Log log graph should have gradient exactly 0.5 to support this theory ✓ Reference to explanation why gradient is lower than expected because mass of ruler and spring not included in theory / reference to quality of data / scatter of points about line ✓	**3**	
	Total	**10**	

ISA (P) Oscillations of a spring

Question 3		Mark	Additional guidance notes
3(a)(i)	1.1 % ✓ (from 0.5 × range / t mean)	**2**	Allow 1 % No sf penalty
3(a)(ii)	1.1 % (uncertainty in T will be same) ✓		Allow ecf from 3(a)(i).
3(b)	Variation in reaction time ✓	**1**	Do not accept "human error".
3(c)	Random ✓	**1**	
3(d)	k = 43.0 N m^{-1} ✓	**1**	No sig fig penalty. No unit penalty.
3(e)	% uncertainty on T^2 = 2.2 % (allow ecf from 3(a)(ii)) ✓ % uncertainty in k = 2.2 % + 0.22 % (from L) + 0.67 % (from x) + 2 % (from m) = 5 % or 5.1 % ✓ uncertainty ± 2 ✓ N m^{-1} (one mark for uncertainty in k of ±2, and another mark for the unit)	**4**	Allow 2% at this intermediate stage 2nd mark for showing % uncertainty of k or addition of % uncertainties of individual measurements to arrive at this figure Allow ecf from value of k from 3(d). Allow alternative unit kgs^{-2} No unit penalty. Must be only 2 sf (uncertainty definitely does not suggest an extra sf) Credit mark for unit if correct unit given in 3(d).
	Total	**9**	

ISA (P) Oscillations of a spring

Question 4		Mark	Additional Guidance Notes
4(a)	Card with large area attached to bottom of mass (or other suitable position) ✓	**1**	Alternative responses include: • increase friction at hinge • suspend mass in water • surround mass in sealed tube
4(b)	• Estimate the equilibrium position/zero amplitude position • Measure peak amplitudes • plot ln(amplitude) against time • Straight line graph with negative gradient indicates amplitude decreases exponentially with time ✓✓✓ **3 marks max**	**3**	Allow credit, in line with bullet points, for information shown on the diagram eg labelling amplitudes. Numerical method acceptable: • estimate the equilibrium position/zero amplitude position • measure peak amplitude • take ratio of amplitudes for successive oscillations • same ratio confirms exponential decrease in amplitude
	Total	**4**	