General Certificate of Education

Physics

Investigative Skills Assignment (ISA) P

PHY3T/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) Bouncing Ball Investigation

Stage 1		Mark	Additional guidance notes
(a)	Table with column headings showing clearly all heights, h, with corresponding values for s including at least one column for repeat readings and another for the mean value of s ✓	**1**	Headings can be in words or symbols (h and s) and must indicate clearly which is which.
(b)	**All** units correct in column headings ✓	**1**	Appropriate units: m, cm or mm. Units can be in words or the correct abbreviation. Standard notation for quantity and unit is expected (eg h/cm) but accept units given inside brackets or other notation if the meaning is clear. *Do **not** award this mark if the units are written in the body of the table.*
(c)	Measurements of at least six different values of h greater than or equal to 15 cm, each with a corresponding height, s ✓	**1**	Six is acceptable here (rather than the standard seven) because of the time needed for measurements.
(d)	Range chosen for h at least 40 cm wide ✓	**1**	
(e)	At least three measurements of s for all values of h ✓	**1**	
(f)	Significant figures correct for **all** readings ✓	**1**	Accept only nearest mm for **all** readings for h (eg 600 mm, 60.0 cm, 0.600 m, but **not** 60 cm or 0.60 m.) Accept either nearest mm or nearest cm for s, but **all** values of s must have the same number of decimal places.
(g)	Mean values for s correctly calculated ✓	**1**	No significant figure penalty *Check only second and last calculated values in the table.*

(h)	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 (eg not in multiples of 3, 4, 7 etc.) ✓	**1**	The plotted points should occupy more than half of each axis. Candidates may need to start either axis from a non-zero value to ensure the points occupy a suitably large area of the grid.
(i)	*s* plotted on the vertical axis and *h* on the horizontal axis with both axes correctly labelled with quantity and unit ✓	**1**	Allow error carried forward for incorrect unit(s) from table but **no unit: no mark.**
(j)	Points accurately plotted to within 1 mm ✓ *Check second and third plotted points*.	**1**	This mark is independent of mark (h), ie candidates who have used an unsuitable scale can still achieve the mark for accurate plotting.
(k)	Suitable line of best fit drawn ✓	**1**	A straight line with a positive gradient is expected but it is unlikely to pass through the origin because *h* is the height measured from the bench to the top of the ball. Credit any well drawn straight line or smooth curve that fits the points with an even scatter of points on either side of the line. Points which are obviously anomalous should not unduly influence the line drawn.
	Total	**11**	

ISA (P) Bouncing Ball Investigation

Section A		Mark	Additional guidance notes
1(a)	(B) is the expected answer for any reasonable straight line graph ✓	**1**	Accept (A) only if the straight line has a positive gradient **and** the best fit line passes through the origin. (D) is the correct answer for a best fit curve.
1(b)(i)	± 1 mm	**1**	Unit required but condone missing ±
1(b)(ii)	δs calculated from $\frac{1}{2}$ × (range of repeat readings) for largest mean value of s ✓	**1**	Correct unit needed for the final answer. No sf penalty. Condone missing ± *Accept standard deviation calculation.*
1(b)(iii)	Uncertainty stated between ± 2 mm and ± 5 mm inclusively with unit ✓ with a valid comment ✓	**2**	*Valid comment:* **EITHER** reference to parallax errors **OR** reference to two uncertainties for a distance measurement being added together. **Or** reference to spherical shape of the ball. Condone missing ±
1(c)(i)	x correctly calculated for <u>smallest</u> h ✓	**1**	Answer given with appropriate unit and 3 sf for $x \geq 10$ cm or 2 sf if $x < 10$ cm
1(c)(ii)	Uncertainty for h correctly added to uncertainty for d ✓	**1**	Correct addition of candidate's answers to parts (b)(i) and (b)(iii). Ignore units and sf
1(c)(iii)	ΔE_P correctly calculated for <u>smallest</u> h with unit (J) ✓	**1**	Ignore significant figures
1(c)(iv)	% uncertainty correctly calculated for either x or mg ✓ Clear attempt to calculate $\%\delta x + \%\delta(mg)$ ✓ Fully correct final answer with 1 or 2 sf and % sign ✓	**3**	Accept maximum and minimum method. Award up to 3 marks with reference to the marking points opposite.
	Total	**11**	

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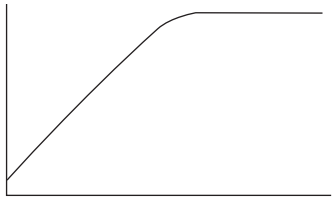
Section B		Mark	Additional Guidance Notes
2(a)	$E_0 = 0.125 \times 9.81 \times (1.620\text{-}1.149) = 0.578\,\text{J}$ ✓	**1**	The question says *show that*, so the candidates must write out the substitution in full. *Accept 0.471 as an alternative to (1.620 – 1.149)* *and/or accept 0.123 as alternative to 0.125 × 9.81*
2(b)	***t*/mm** ***E*/J** 2.50 1.142 3.00 1.266 3.50 1.292 ✓	**1**	All three answers must be exactly as given. 1.136 1.140 1.260 1.264 are alternative **sets** 1.286 1.290 of answers
2(c)	All three points correctly plotted to the nearest mm ✓ Well drawn line of best fit showing the initial constant gradient and then a smooth curve becoming horizontal ✓	**2**	 Allow error carried forward from 2(b)
2(d)(i)	Triangle drawn for the linear part of the graph with smallest side 8 cm in length. ✓ Correct readings taken from the line for the triangle ✓ Gradient: 0.37 ± 0.02 quoted to 2 or 3 significant figures ✓	**3**	The base of the triangle should be at least 8 cm long. The size of the triangle can be implied by readings taken from the line. *Expect to see the linear part of the graph extended to give a gradient triangle with a minimum base of 8 cm or four grid squares.*
2(d)(ii)	Jmm^{-1} ✓	**1**	Accept Jm^{-1} or N provided unit consistent with value quoted
2(e)(i)	Value in the range 3.2 to 3.6 mm ✓	**1**	Accept only 2 or 3 sf with unit stated
2(e)(ii)	$1.292 \times 0.7 = 0.904$ ✓ or 0.900 or 0.903 $t = 1.85 \pm 0.02$ mm ✓	**2**	*This mark is implied if the answer for t is correct.* Accept 2 or 3 sf only for final answer. No unit penalty. Alternative acceptable answers for the first mark are 0.900 and 0.903. An acceptable alternative interpretation of the question gives $t = 1.75 \pm 0.02$mm

2(f)(i)	± 0.67 %	**1**	Accept 1 or 2 sf only. *Condone missing ± and/or missing % sign.*
2(f)(ii)	The percentage uncertainty in *s* is ± 0.19 % ✓ The measurement of *s* is the more accurate ✓	**2**	A correct calculation for the percentage uncertainty in *s* is needed for the first mark but do not penalise significant figures. The second mark is dependent on the first but allow ecf for incorrect % calculation here and/or in 2(f)(i)
	Total	**14**	

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Question 3		Mark	Additional Guidance Notes
3	***Where alternatives are indicated award only one of the two marks.***		*Please note, next to your tick, the letter corresponding to the marking point being awarded* (*eg* ✓ a).
	(a) Plausible method for releasing the ball ✓	**1**	Award this mark if the candidate clearly recognizes that the diameter (10 cm) of the ball is too large for it to be held in a standard clamp. *eg accept "use a much larger clamp to release the ball"*
	(b) Method for controlling and measuring the temperature of the ball **OR** (c) Repeat the procedure for at least seven different temperatures ✓	**1**	*eg* a large beaker of heated water **with** a thermometer *or* temperature controlled oven / incubator *or* a water bath **with** a thermostat *or* allow time for ball to reach temperature of the water bath
	(d) *h* kept constant as a <u>control variable</u> **OR** (e) Transfer the ball from the water bath to the clamp quickly to minimise heat loss	**1**	The candidate must say why *h* is to be kept constant. *Accept "fair test" as an alternative to "control variable"*
	(f) Handle the hot ball with tongs to avoid burns ✓	**1**	*Accept any reference to taking care when handling the hot ball*
	(g) Improved method for measuring *s* **OR** (h) Take repeat readings of *s*, <u>reheating the ball each time</u> ✓	**1**	*eg* measurements from strobe photography *or* still frames from a video recording Accept measurements taken with a *data logger with a position (or motion) sensor.*
	Total	**5**	