



**General Certificate of Education (A-level)  
June 2012**

**Physics**

**Investigative Skills Assignment (ISA Q)**

**PHY3T/Q12/mark**

**Written Test**

**Final**

***Marking Guidelines***

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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 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 **31<sup>st</sup> 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.

## ISA (Q) Projectiles

Stage 1		Mark	Additional guidance notes
(a)	Single table with column headings showing all recorded results for $y$ and $d$ <b>and</b> All units correct in column headings ✓	1	Column headings can either be in words or standard symbols. Do not penalise here for not taking repeat readings (see (c) below). Units can be in words or the correct abbreviation, eg height/millimetres, $h/mm$ . Allow also units in brackets, eg $d(m)$ , $d(\text{millimetres})$ or written in form ' $y$ in $mm$ ' etc.
(b)	Decimal places correct for all $y$ and $d$ readings. Should be quoted to nearest $mm$ ✓	1	
(c)	At least two repeat readings (ie 3 readings altogether) of $y$ for each value of $d$ , shown in table with column for mean value ✓	1	
(d)	Correct computation of mean value of $y$ , <i>quoted to nearest mm</i> for <b>first</b> and <b>last</b> values in the table ✓	1	
(e)	Axes labelled with quantity and unit: $y/mm$ on the vertical axis and $d/mm$ on horizontal axis ✓ (units also acceptable in $cm$ or $m$ ).	1	Alternative method of labelling axes as in (a) above for table headings and units. Allow ecf where same unit penalty has already been applied in (a). Do not award mark if axes wrong way around.
(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 in multiples of 3, 4, 6, 7, 9, etc are unsatisfactory ✓	1	The plotted points should occupy at least half of each axis, with the scale(s) starting at non zero values if necessary.
(g)	Points accurately plotted to within $1\text{ mm}$ ✓ Checking first and last points on the graph. No mark if either of these 2 points are incorrect.	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.

**ISA (Q) Projectiles**

(h)	Line of best fit drawn ✓	1	Expected to be a straight line. To award the mark the line should have approximately an equal number of points on either side of the line. Points which are obviously anomalous should not unduly influence the line. If the points clearly suggest a smooth curve, the mark can be awarded for an appropriate smooth curve.
<b>Total</b>		<b>8</b>	

Section A		Mark	Additional guidance notes
1(a)	<ul style="list-style-type: none"> <li>• Height/angle/slope of ramp</li> <li>• Height/angle/slope of drawing board</li> <li>• The angle of projection (45° line)</li> </ul> Any two of above points for 2 marks ✓✓	2	Reference to marble not accepted – candidates only have one marble with no alternative choice so it is not strictly a control variable. Also reject same ramp, same drawing board.
1(b)	Correct value of % uncertainty quoted from: uncertainty = $(\pm) 0.5 \times$ spread of repeats ✓	1	No penalty for omitting $\pm$ . No sig fig penalty. Candidates who did not take repeat readings do not have access to this mark.
1(c)	Suitable method to mark the position where marble reaches maximum height ✓ Use of set square to draw perpendicularly from bottom of board to marked position and measure $y$ ✓	2	There are two essential points in the answer: <ul style="list-style-type: none"> <li>• 1<sup>st</sup> mark is for a method of marking the maximum height of the marble on the board.</li> <li>• 2<sup>nd</sup> mark is for using a set square to ensure the maximum height is measured perpendicularly from base.</li> </ul> NB If candidate mentions accurate method of determination of bottom/base position, this can be awarded a mark in 1(d) if required.

## ISA (Q) Projectiles

1(d)	<ul style="list-style-type: none"> <li>Reliable release method for marble to ensure it is not released with an initial velocity (eg putting barrier in front of marble and pulling away quickly).</li> <li>Method using video (camera), <b>with clear scale drawn onto paper.</b></li> <li>Any method which leaves a track on the board such as carbonised paper which leaves an exact track from which accurate measurements can be made.</li> <li>Accurate determination of the bottom/base position (possibly carried over from 1(c)).</li> </ul> Any two of above 4 points ✓✓	2	No credit for using light gates.
1(e)	Correct statement saying whether experiment is reliable or not together <b>with</b> explanation in terms of closeness of repeat readings ✓ Correct statement saying whether experiment is reliable or not together <b>with</b> explanation in terms of closeness of points to line of best fit ✓	2	No mark for just statement that experiment is reliable or not without explanation.
1(f)	Gradient steeper/larger value ✓ Sensible reference to PE (eg gains same PE as before and will go further to achieve same vertical height) ✓	2	Can also apply to steepness of curve if curve was drawn. Explanation with reference to component of acceleration/forces down slope can also be credited.
1(g)	Graph is a straight line passing through origin ✓ This indicates (direct) proportionality ✓	2	Where either or both axes do not start at zero it is not possible to determine by observation if there is direct proportionality or not between the plotted quantities. Access to both marks is still possible where a student acknowledges this point. Award 1 mark only if candidate refers to straight line showing (direct) proportionality without mentioning passing through origin. If candidates graph was a curve by reference to $y$ increasing with $d$ for the 1 <sup>st</sup> mark, and statement that relationship is non linear/not proportional for 2 <sup>nd</sup> mark.
<b>Total</b>	<b>13</b>		

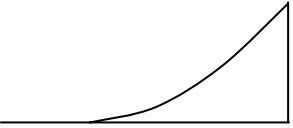
**ISA (Q) Projectiles**

<b>Section B</b>		<b>Mark</b>	<b>Additional guidance notes</b>
<b>2(a)</b>	154, 191, 228 ✓	<b>1</b>	No mark if additional sig fig quoted on any value.
<b>2(b)</b>	3 points correctly plotted to within $\pm 1$ mm from exact position ✓ straight line of best fit drawn ✓	<b>2</b>	Same criteria for the straight line as in stage 1 (h).
<b>2(c)</b>	Triangle drawn with smallest side at least 8 cm ✓ correct values read from graph ✓ gradient in range 1.70 to 1.80 must be to 2 or 3 sf ✓	<b>3</b>	Gradient must lie within limits stated. No ecf from incorrectly read values unless it falls within stated limits. No unit penalty.
	<b>Total</b>	<b>6</b>	

## ISA (Q) Projectiles

Question 3		Mark	Additional guidance notes
3(a)(i)	(±) 3.8% or 4% ✓ (calculated from uncertainty = 0.5 × spread of repeats)	1	No penalty if ± omitted. No penalty if % sign omitted.
3(a)(ii)	% uncertainty in $d = (\pm) 3.3\%$ or 3% ✓ % uncertainty in $x/d = (\pm) 7.1\%$ also allow 6.8, 7, 7.1, 7.3% ✓ Answers must be as stated to 1 or 2 sf.	2	No penalty for omission of ± or % sign. Allow ecf from 3(a)(i) or from 1 <sup>st</sup> part of 3(a)(ii) for 2 <sup>nd</sup> mark.
3(a)(iii)	Random ✓	1	
3(b)(i)	Calculated from $\frac{(\text{difference})}{(\text{gradient value})} \times 100$ or $\frac{(\text{difference})}{(\text{predicted value})} \times 100$ ✓ Allow variations in answer from student's value of gradient.	1	No sf penalty. Allow ecf from incorrect gradient value. No penalty for omission of % sign.
3(b)(ii)	<ul style="list-style-type: none"> <li>Points out that the prediction is outside/greater than the likely uncertainty in the data.</li> <li>Random error cannot account for large % difference.</li> <li>Suggests possible unexplained systematic errors.</li> <li>Reference to friction between marble and board not taken account of in theoretical prediction.</li> </ul> 2 marks for any 2 of above points ✓✓	2	Allow explanations consistent with small percentage difference in answers to 3(a)(ii) and 3(b)(i).
	<b>Total</b>	<b>7</b>	

## ISA (Q) Projectiles

Question 4		Mark	Additional guidance notes
4(a)	Curved ramp with last section horizontal to give horizontal projection ✓ Different reproducible speeds obtained by putting marble higher up ramp ✓  Or explained diagrammatically Ramp shaped like this  	2	Any sensible alternative, eg <ul style="list-style-type: none"> <li>• Spring loaded device arranged to project marble horizontally ✓ and varying compression of spring by measured amount gives variable reproducible projected speed ✓</li> <li>• Catapult arranged to project marble horizontally ✓ and pulling elastic back by different measured amounts will give variable reproducible speed ✓</li> </ul> For 2 <sup>nd</sup> mark it must be made clear how speed is varied <b>and</b> reproducible.
4(b)	<ul style="list-style-type: none"> <li>• Light gate positioned for ball to pass through it as it leaves the bench.</li> <li>• High enough so diameter of ball goes through middle of gate.</li> <li>• Measure diameter of ball.</li> <li>• Computer measures time.</li> <li>• Computer computes  <math display="block">\text{speed} = \frac{\text{distance (diameter)}}{\text{time}}</math> </li> </ul> 5 max 4 ✓✓✓✓	max 4	
4(c)	Plot graph of $r$ against $v$ or $v$ against $r$ , <b>and</b> <b>a straight line through origin verifies statement</b> ✓	1	
	<b>Total</b>	<b>7</b>	