AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics
Investigative Skills Assignment (ISA) Q

PHY3T/Q09/mark
Written Test

Marking Guidelines
2009 examination – June series

Mark Guidelines Explanatory Notes

The mark 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 guidelines 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 would have to take other steps to ensure that candidates did 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 from the mark scheme, e.g. '✓b'. **No other comments or feedback should be written on the candidates' script.** 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.

There will be 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 2009. Assessment advisors are also allocated to each centre and they can also advise on the marking process.

ISA (Q) Speed of Waves in Water

Stage 1		Mark	Additional guidance notes
(a)	Table with column headings showing all recorded results for distance and time measurements	1	Column headings can be either in words or standard symbols.
(b)	**All** units correct in column headings	1	Units can be in words or the correct abbreviation. E.g. Time/seconds, time/s. Alternative acceptable labelling includes time (s), time in s etc.
(c)	Decimal places correct for all readings, compatible with precision of instruments used	1	E.g. A stopclock with precision ±0.01 s. An acceptable reading would include 4.20 s, whereas 4.2 s is unacceptable.
(d)	Repeat depth and repeat tray length measurements, quoted with correct unit	1	
(e)	Correct computation of distance travelled across tray	1	Candidates have multiplied number of time wave travels across tray by length of tray. Calculation need not be shown but distances must be correct.
(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)	1	The plotted points should occupy at least half of each axis.
(g)	Correctly labelled axes with units	1	Both axes labelled with quantity and unit. Words or symbols may be used for physical quantities and units. E.g. time/seconds, t/s. Acceptable alternative labelling includes t (s), time (s), time in s.

ISA (Q) Speed of Waves in Water – continued

Stage 1		Mark	Additional guidance notes
(h)	most points accurately plotted to within 1 mm (no more than one point > ± 1 mm)	1	This mark is independent of mark (f), i.e. if candidates have used an unsuitable scale they can still achieve marks for accurately plotting the points.
(i)	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. If the plotted points suggest a curve line, the mark can be awarded for a suitable smooth curve.
(j)	Correct answer for average speed and unit	1	
	Total	10	

Section A				
Question 1				
(a)		Width of tray, length of tray ✓	**1**	Also allow water temperature, air pressure.
(b)		Estimated from 0.5 × spread of repeat readings No unit penalty ✓	**1**	Do not allow instrument precision.
(c)		uncertainty calculated correctly from % uncertainty = $\dfrac{\text{uncertainty}}{\text{largest time}} \times 100$ ✓ allow e.c.f.	**1**	
(d)	(i)	Correct computation of mean depth (quoted to same number of significant figures as individual readings for depth) ✓	**3**	Also allow reference to difficulty in reading rule with meniscus/ uneven tray bottom.
	(ii)	Rule or measuring device not vertical or perpendicular to water surface/tray not horizontal ✓		
	(iii)	Take more repeat readings ✓		
(e)	(i)	Correct computation with appropriate significant figures ✓ (Allow e.c.f. from speed and depth measurements)	**2**	Appropriate significant figures would normally be 2 or 3, compatible with time and distance and depth measurements.
	(ii)	m s^{-2} ✓		Allow m/s^2 or unit written out in words.

Section A			
Question 1			
(f)	Straight line showing constant or uniform speed ✓ Explanation that as wave travels further (more times across tank) speed remains the constant ✓	**2**	To achieve the second mark there must be clear evidence in the statement that the speed remains the same even as the wave travels more times across the tray. If a candidate's result gives a curved graph, then an appropriate description of how the speed changes can still be awarded credit.
	Total	**10**	

Section B

Question 2

(a)	all 3 correct average depth values: 0.030, 0.035, 0.039 m ✓ all 3 correct c^2 values: 0.29, 0.35, 0.38 m² s⁻² ✓ (no significant figure penalty)	**2**
(b)	all 3 points plotted to nearest mm ✓✓ **or** any 2 points plotted to nearest mm 1 mark line of best fit drawn through points ✓	**3**
(c)	Triangle drawn with smallest horizontal side at least 7 cm ✓ correct values read from graph correct answer for gradient 9.8 ms⁻² ✓ (allow 9.8 ± 0.2 ms⁻², or calculation based on e.c.f. from incorrectly read scale value(s); no unit penalty)	**3**
(d)	graph shows c^2 is proportional to h	**1**
(e)	% difference correctly calculated (no significant figure penalty) ✓ Relevant comment: Expect value to be close to accepted value because repeat results **or** points close to the line of best fit on the graph suggest small uncertainty in results. /Data quoted to 2 significant figures cannot justify a 3 significant figure value for g. ✓ No mark for just stating that the value is close to or equal to the accepted value without an additional relevant comment N.B. A value of g close to the accepted value does **not** in itself confirm that the uncertainty in the experiment is small.	**2**
	Total	**11**

Section B				
Question 3				
(a)	(i)	Uncertainty 0.002 m or 2 mm ✓ (calculated from 0.5 × spread of repeat readings)	**2**	
	(ii)	Random error ✓		
(b)		Points close to line of best fit /no anomalous points indicating reliability.	**1**	
(c)	(i)	12 % (2 × uncertainty in c) ✓	**3**	
	(ii)	% uncertainty in depth = 1/10 × 100 = 10 % ✓ Hence wavespeed *c* contributes more to overall uncertainty in value of *g*		Statement of percentage uncertainty = 10 % is sufficient, without calculation.
		Total	**6**	

Section B			
Question 4			
	Any 4 of the following points	**4**	
	• Vary depth with deeper tray/tank		
	• Suggested range of depths – range must cover depths to at least 0.120 m (3 × the depth in the original experiment)		
	• Improved method of measuring depth e.g. from measurements of volume of water and area of tank		
	• Alternative method of producing wave since tray/tank much heavier, e.g. dipper		
	• Measure speed by timing waves across tank		
	• Suggested improvement to speed measurements e.g. longer tank to increase times/more (at least 3) repeat timings		
	• Plot graph of c^2 against h to see if still proportional		
	✓✓✓✓ 4 marks max		1 mark may also be awarded for any other workable modification or improvement not mentioned in the left-hand column.
	Total	**4**	
	Total	**21**	

9