ASSESSMENT and QUALIFICATIONS ALLIANCE

## General Certificate of Education

# Physics

## PHA3/B3/T Investigative and Practical Skills in AS Physics

# Report on the Examination

*2009 examination - June series*

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## GCE Physics, PHA3/B3/T, Investigative and Practical Skills in AS Physics

### General Points

In both ISA tests candidates were able to follow instructions on the task sheet and successfully take a set of appropriate results. Feedback from centres suggested that the experiments worked well and no generic problems were reported.

### Administration Procedures

The vast majority of centres followed administration procedures efficiently with sample scripts and centre mark sheets arriving with moderators by the prescribed deadline. There were problems with some centres however, with scripts arriving well beyond the deadline and centre declaration forms or candidate record forms either missing or unsigned. A few centres did not provide PSA marks until requested.

### Marking

A tolerance of ±3 is allowed on the ISA test before centres marks are adjusted. The majority of centres marked the scripts accurately in accordance with the marking guidelines. Most centres were within the allowable tolerance, and only a small percentage had marks adjusted.

The most common marking errors were related to graphs. Unsuitable scales, scales which were too small, incorrectly plotted points and inappropriate lines of best fit were frequently awarded credit. Specific advice on marking tables, graphs and significant figures was given at the compulsory teacher standardising meetings last autumn. Advice is also available through documents published in the Teacher Resource Bank and from the allocated Assessment Adviser. Further details of marking errors in specific questions are mentioned later in the detailed report on each ISA.

### PSA

As expected most middle and higher grade candidates achieved full marks on this component. Less able candidates typically lost one or two marks out of the nine available.

### ISA P Emf and Internal Resistance

### Stage 1

Overall most candidates scored well on this section, with a large proportion achieving nine or ten marks. Almost all candidates were able to set up the circuit and take the required range of pd and current readings. Repeat readings were not required on this task because of possible problems due to changes of the emf of the cell between readings. It was encouraging, however, to see that many candidates were able to take a suitable number of repeat readings.

The circuit diagram was usually correct. Occasionally, a battery symbol (two or more cells in series) was used instead of the symbol for a single cell, in cases where a single cell only had been used. The symbol for a variable resistor was also used instead of the symbol for a fixed resistor. No mark should be awarded in these cases.

Tables, column headings and units were usually correct. Centres are advised to encourage students to use the ASE convention for symbols or units, although other alternatives are allowed on the mark scheme. Please note that lower case symbols for ampere or volt are not acceptable and marks should not be awarded.

Graph scales caused problems for some candidates. In this graph, it is usually necessary to start both axes from non-zero values of $V$ and $I$ in order to ensure that the plotted points occupy at least half of each scale. Some candidates used inappropriate multiples on scales. In general only multiples of two, five and ten are easy to read and are acceptable. A significant number of candidates made errors in both plotting points and drawing the line of best fit. The line of best fit should have an approximately equal distribution of points around the line.

Marks were often awarded where several points were incorrectly plotted and the line of best fit was inappropriate. Markers are requested to check a sample of the points plotted, focusing on any suspect points. Typically two or three points are adequate, and the points checked should be indicated with a red square around the point. Moderators will usually remark the same points.

**Section A**

**Question 1**

Part (a) was an easy mark for most candidates. The unit is required for this mark and this was omitted by some candidates.

In part (b), most candidates were able to correctly calculate the percentage uncertainty in the smallest ammeter and voltmeter readings. The mark was awarded for the correct answer only, and details of the calculation were not required.

To achieve the mark in part (c), reference should be made to the uncertainty values calculated in part (b).

Part (d) was more challenging. Many candidates achieved the first mark for acknowledging that a high value resistor would produce a small current. The second mark proved more difficult with correct answers referring to the high percentage uncertainty or ammeter precision too large to give a measurable reading.

The possibility of the cell ‘running down’ was the key point required in part (e). Marks were not allowed for reference to heating effect of the external resistor and causing its value to increase since this has no effect on the emf of the cell.

In part (f), candidates should refer to the closeness of points to the line of best fit to justify whether their experiment is reliable or not. Alternatively, where candidates took repeat readings they could refer to these to justify their statement on reliability.

A significant number of candidates simply stated that their experiment was reliable because they took repeat readings, without justifying whether the repeats were consistent or similar.

Most students correctly stated emf and internal resistance in part (g). The negative sign is not required in (ii) since the question refers to the ‘physical quantity’.

**Section B**

**Question 2**

Part (a)(i) produced many disappointing answers, with many candidates not using a sufficiently large Δy and Δx or misreading data from the graph. Many candidates also lost a mark for omitting the negative sign in the gradient value.

It should be noted that the minimum size triangle/Δy, Δx should be 8 cm, as previously published, for all ISA and EMPA papers. A slightly lower figure of 7 cm was allowed on this year's ISA only.

Part (a)(ii) was a good discriminator for the more able candidates. To achieve the mark, candidates had to make it clear that the gradient represented the combined total internal resistance of cell A and cell B.

Many candidates plotted at least one of the three points incorrectly in part (b). Lines of best fit were also often incorrect, with some lines even bent to fit incorrect points. Unfortunately, this was often unnoticed by markers, who awarded the full three marks for work which had incorrectly plotted points and lines.

Part (c) was another good discriminator. The key point required is that reversing one of the cells does not affect the total internal resistance of the two cells in series, and hence the gradients are the same.

Only the most able candidates scoring two or three marks in part (d). The first part of the question was more straightforward with candidates able to deduce the value of $\varepsilon_{(A-B)}$ = 7.5 V directly from the graph intercept.

Deduction of $\varepsilon_A$ was clearly more difficult, requiring comparison of intercepts on both lines, and explanation in terms of either simultaneous equations or explanation as to why $\varepsilon_A$ is the mid-point between the two intercepts.

**Question 3**

An easy mark was provided in part (a) for most candidates who could calculate correctly the maximum possible resistor values as 18.9 Ω.

Part (b) was much more discriminating, correctly answered by only the more able candidates. The answer required some explanation referring to the fact that any change of external resistor does not affect the result for the emf measured in this experiment.

Part (c) was answered well by most candidates who were able to correctly state systematic error or zero error for (i) and explain how this would affect the emf measured in (ii).

Some candidates did not realise that the gradient is unaffected in part (c)(iii).

**Question 4**

This question discriminated well, with only the most able students scoring three or four marks. Many less able students made irrelevant comments and marks of zero or one were quite common.

Marks can only be awarded for statements which match the points listed in the mark scheme. Some markers were too generous on this question, awarding marks for vague or incomplete statements.

Many students find this type of 'open response' question more difficult. As a general guide in this type of question students should be advised to

- explain how to set up the experiment or draw a circuit diagram (or apparatus diagram)
- make it clear what needs to be varied (with possible range of values) or what needs to be kept constant (if relevant)
- give details of how results are to be processed (eg how power supplied is calculated) and possible graph(s) to be drawn and what deductions can be made.

This approach would give access to most of the marking points available.

**ISA Q Speed of Water Waves**

**Stage 1**

Overall candidates scored well on this section with a large proportion of candidates achieving nine or ten marks. Almost all students were able to achieve timings for at least six crossings of the tray with suitable repeat readings.

Some candidates did not take or record readings for depth of water and/or tray length as required in the instructions, with the consequent loss of one mark.

Tables, column headings and units were usually correct. The only exception was that a small number of candidates quoted distance travelled in units of 'tray lengths' and did not use their measured tray length to compute the actual distance travelled by the wave.

The majority of candidates produced suitably labelled graph scales with sensible divisions. There were a few notable exceptions however, including where some candidates had again used distance measurement in 'tray lengths'. In a few cases, even where candidates had converted tray lengths into distances, they used major scale divisions to represent an exact tray length measurement, again resulting in loss of the allocated mark. Despite being given clear instructions to plot distance on the y-axis and time on the x-axis, a small proportion of candidates lost a mark by plotting the graph the wrong way around.

As with ISA P, a significant number of candidates made errors in plotting points. In many cases the line of best fit drawn was also incorrect. This was because of either an unequal distribution of points around the line or the line deliberately being deliberately 'forced' through the origin.

Most candidates were able to correctly deduce the wave speed, either from the gradient of their graph or from individual distance and time readings.

Although most centres marked this section accurately, there were a significant number of cases where marks had been awarded for incorrectly plotted points and unsuitable lines of best fit. Markers are only required to check a proportion of points plotted, focusing on any suspect points. The points checked should then be identified by a red square around the point, enabling moderators the opportunity to remark the same points.

**Section A**

**Question 1**

Part (a) proved to be a difficult first question with only the more able candidates giving the expected answer. There was some debate as to whether 'height tray dropped from' was an acceptable alternative. Although for the depth of water used, this does not affect the speed of the wave at much greater depths it can have an effect. Consequently, centres marks on this point were allowed, to avoid any unfair penalty.

Candidates were specifically instructed to take repeat readings of timings in part (b). Consequently, the uncertainty in the large time measurement should be based on the spread of these repeats, using **uncertainty = 0.5** × **spread of repeats**. The majority of candidates did this correctly (this simple rule was published by AQA in the many support materials and specimen papers, as being an acceptable method of estimating uncertainty without the requirement for more advanced statistics). In the very unlikely event of identical repeat time readings, the uncertainty would then be based on the instrument precision.

Part (c) was a straightforward question, correctly answered by most candidates. Error carried forward was allowed from an incorrect answer in (b).

Part (d) (i) was usually answered well. Candidates were required to state the mean depth to the same number of significant figures as their initial depth readings. This is normal practice for a small number of repeat readings, which would usually not justify statistically an extra significant figure.

Part (d) (ii) was answered well by the majority of students, usually referring to the ruler not being vertical. 'Worn end of ruler' was also a common answer, and was allowed if verified by the centre that the rulers used were indeed worn, perhaps with a resulting systematic error of 1 - 2 mm.

Repeat readings was the most common way to improve the accuracy of the mean value, and this was the most common answer from candidates to part (d) (iii). Other correct answers included using naming an instrument with better precision, such as callipers with 0.5 mm divisions or vernier scale. Just stating a ruler with 'more divisions' was not acceptable.

Part (e) (i) was answered well by most candidates who were able to use their results and compute a correct vale for $c^2/h$. Unfortunately, many candidates were penalised for quoting an unrealistic number of significant figures.

The unit in part (e) (ii) was correctly stated by all but the less able candidates.

Part (f) was a good discriminator with only the most able candidates achieving both marks. The easier first mark was for recognising that the straight line indicates constant speed. The second mark was for pointing out that wave speed is unchanged as the wave travels further.

**Section B**

**Question 2**

Part (a) was answered well by almost all candidates.

The points in part (b) were plotted accurately by most candidates but a significant proportion of candidates did not draw an acceptable line of best fit, failing to leave an approximately even distribution of points around the line.

The answers to part (c) were a little disappointing with many less able candidates achieving only one mark. The most common errors were choosing values for $\Delta y$ and $\Delta x$ which were too small and misreading data from the graph. Please note that for gradient calculation the minimum size triangle/$\Delta y$, $\Delta x$ is 8 cm, although 7 cm was allowed in this year's ISA only.

Part (d) was answered well by most candidates, acknowledging direct proportionality between the plotted points. Vague statements such as 'positive correlation' were common incorrect answers.

Most candidates were able to compute the percentage difference in part (e). Only the more able candidates were able to offer a suitable comment, which should relate to implied accuracy/uncertainty in the experiment.

Lines were omitted on the script for comments, but centres were notified by AQA. There was no evidence that this was a problem for candidates.

**Question 3**

Part (a) (i) was answered well by most candidates using the formula **0.5** × **spread of repeats**.

Most candidates realised this was a random error in part (a) (ii). 'Human error' was the most common incorrect answer, offered only by the less able candidates.

The expected answer to part (b) should have referred to the closeness of points to the line of best fit. This was answered correctly by a large proportion of students.

In part (c) (i), candidates should be aware that in squaring a quantity, the uncertainty is doubled, giving 12% in this case. Although correctly answered by a large proportion of candidates, 6% was still a popular answer.

Part (c) (ii) discriminated well, with only the more able candidates able to score both marks. Marks could only be achieved for this question by first calculating the percentage uncertainty in the depth from the data given. They should then make a comparison between the percentage uncertainty in the depth (10%) and the percentage uncertainty in $c^2$ (12%). Just stating that velocity contributes more to the overall uncertainty is insufficient for even one mark, unless there is a comparison with a numerical value for the uncertainty in depth. Error carried forward can be allowed from an incorrect assumption in (c) (i).

**Question 4**

This question discriminated well, with only the most able candidates scoring three or four marks. Many of the less able candidates did not gain any marks on this question.

Many candidates simply described the experiment they had already done, without suggesting improvements or modifications which might be necessary when using a greater depth of water. To achieve higher marks, it was essential to address potential problems of conducting the experiment with a much greater depth of water, suggest improved methods for producing the wave and refinements to achieve more accurate speed measurements. When suggesting methods of analysing results to test the hypothesis, a statement of the exact graph to plot and the expected outcome was required.

Marking of this question was often too generous. Marks should only be awarded for specific points mentioned in the mark scheme.

**Mark Ranges and Award of Grades**

Grade boundaries and cumulative percentage grades are available on the Results statistics page of the AQA Website.