Version 1.0

General Certificate of Education (A-level)
June 2012

Physics PHA3/B3/T

Unit 3: Investigative and practical skills in AS Physics

Report on the Examination

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Set and published by the Assessment and Qualifications Alliance.

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

General Comments

Reports from moderators confirmed that ISA P (Resistors in parallel) and ISA Q (projectile motion) were equally popular in the scripts sampled, suggesting an equivalence in standard of both ISA's.

Feedback from centres suggested the experiments worked well, enabling students to take the data required with no significant problems with apparatus.

Administrative Issues

Most centres dealt with administrative issues efficiently, ensuring that scripts, Centre Mark Sheets, Centre Declaration Forms and Student Record Forms were delivered to moderators by the prescribed deadline.
There were only a few instances where scripts arrived late or with missing documentation.
Unfortunately there were again a small but significant number of centres where arithmetic and transcription errors were discovered on scripts sampled. This is a concern and it is the centre's responsibility to ensure correct addition of PSA marks to the marks for each section of the ISA test. Although some errors are discovered and corrected by moderators only a proportion of scripts are checked and remarked in the moderation process, with the possibility of other errors left undiscovered.

Centre Marking

The standard of marking was very good in most cases, with markers carefully following the mark scheme.
As in previous years there were, however, a significant number of centres where marking was outside the tolerance of $\pm$ 3, and in these cases an adjustment to centre marks will usually be made. In all of these cases the marking was too lenient, rather than too severe.
The most common marking errors were condoning:

- Distance measurements quoted to nearest cm rather than mm.
- Unsuitable graph scales
- Incorrectly plotted graph points
- Inappropriate lines of best fit
- Missing units in questions where the mark scheme specifically stated that the correct unit was required.
- Incorrect significant figures where this had been specified as part of the marking point
- 'Weak' explanations, not fulfilling the requirements specified in mark scheme

ISA P

Stage 1

Almost all students were able to follow the instructions and successfully complete the experiment.
The most common errors were:

- Values of resistors quoted with an extra (zero) significant figure added i.e. 22.0 rather than 22 kΩ
- Graph scales which were too small – occupying less than half of each axis. (Scales in 4's were allowed in some instances, providing the data plotted 'easily' on the scale and where no other scale was appropriate).
- Inappropriate lines of best fit, usually with an uneven distribution of points on either side of the line.
- Incorrectly plotted points.
- In a few cases 1/*R* was interpreted was interpreted as *I*/*R*, leading to confusion over units etc.

Section A

Question 1

In part 1(a) clearly the property of 'resistance' is the correct answer and the name of the device 'resistor' was not allowed.

Part 1(b) was a straightforward calculation of uncertainty based on 0.5 X range, and converted to a percentage. An uncertainty of zero in not acceptable, and where there is no spread of repeated readings the instrument precision should be used.

Part 1(c) proved to be straightforward and only the very weakest students failed to correctly compute the maximum and minimum values. A more common error was to miss the unit.

Parts 1(d)(i) & (ii) discriminated quite well, with the higher grade students able to explain the reduction in current and give a plausible explanation as to whether it produced a random or systematic error. Both types of error were allowed provided an appropriate explanation was given.

In part 1(e) although this type of question appears every year in some form, students are still confused about the difference between (direct) proportionality and linearity. For a straight line which does not go through the origin the relationship between plotted quantities is linear and not proportional.
Where a non zero scale has been used students should realise that they cannot say whether or not the line would go through the origin and therefore can only say for definite that it is a linear relationship. Other alternatives to 'linear' are given in the mark scheme.

Part 1(f) was a very accessible mark requiring reference to spread of repeat readings **or** closeness of points to line of best fit.

Section B

Question 2

In part 2(a) completion of the table proved to be an easy task for most students.

For part 2(b) most students were able to plot the three points correctly but a small but significant proportion of students were unable to draw an appropriate line. Some students tried to 'force' the line through the origin.

In part 2(c) although determination of the gradient is a standard question on all ISA's many students still fail to achieve the full 3 marks. The most common error is misreading of one of the data points, and this then usually gives a gradient value out of tolerance, hence losing another mark. Some students still draw triangles (or use equivalent data points) with sides less than the minimum 8cm required.

Part 2(d)(i) did discriminate, and most successful students recognised the intercept and made reference to the equation of a straight $y = mx + c$.

In part 2(d)(ii) most students realised *k* was the gradient of the graph but in some cases failed to quote the unit or a suitable number of significant figures.

In part 2(d)(iii) most students recognised that the intercept of the graph was required but in many cases lost credit by missing off the unit

Part 2(e) worked well, and proved straightforward for higher grade students but discriminated at the lower grades.

Question 3

In parts 3(a)(i) & (ii) straightforward percentage uncertainty calculations were attempted well by all but the weakest students, although some did forget to convert the absolute uncertainty into a percentage.

Part 3(a)(iii) required adding the percentage uncertainty from parts (i) and (ii) and weaker students were unsure of this process. A proportion of students also quoted too many significant figures in their answer.

Part 3(b) discriminated well at the higher grades. Only the most able students understood how the significance of the percentage uncertainty in the resistance measurement affected the suitability of this method for measurement of small variations of resistance.

Question 4

This question discriminated well, with only higher grade students achieving 3 marks or more. Many students give statements which are too vague to achieve the marking points stated in the mark scheme. Credit can only be awarded for the specific points mentioned in the mark scheme.

ISA Q

Stage 1

Almost all students were able to follow the instructions and successfully complete the experiment.

The most common errors were:

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- Lengths quoted to nearest cm rather than nearest mm.
- Graph scales which were too small – occupying less than half of each axis.
- Inappropriate lines of best fit, usually by deliberately trying to 'force' the line through the origin.
- Incorrectly plotted points.

Section A

Question 1

Part 1(a) was answered well by most students, although the most common incorrect answer was to refer to the marble.

Part 1(b) was a straightforward calculation of uncertainty based on 0.5 X range, and converted to a percentage. An uncertainty of zero is not acceptable, and where there is no spread of repeated readings the instrument precision should be used.

Part 1(c) required details of a suitable measuring technique. Many students failed to explain how to measure the height **perpendicularly** from the base.

Part 1(d) discriminated well with only the more able students able to suggest two improved experimental techniques which might reduce the uncertainty in *y*.

Part 1(e) was a straightforward question but for both marks students need to make reference to variation of repeat readings **and** closeness of points to the line of best fit.

In part 1(f) the first mark proved relatively straightforward but only the most able students were able to provide a satisfactory explanation in terms of the physical principles involved.

For part 1(g) in situations where the results produced a straight line through the origin students were easily able to deduce (direct) proportionality. Where the line does not go through the origin or a broken/non zero axis is used, students find it much more difficult to use appropriate terminology. As already mention in comments in ISA P, the difference between (direct) proportionality and linear is often confused.

Section B

Question 2

Part 2(a) was an easy mark achieved by most students.

In part 2(b) point plotting was done accurately by most students. Some students were penalised for inappropriate lines of best fit.

For part 2(c), as with ISA P, many students still failed to achieve the full 3 marks for determination of the gradient. The most common error is misreading of one of the data points, and this then usually gives a gradient value out of tolerance, hence losing another mark. Some students still draw triangles (or use equivalent data points) with sides less than the minimum 8cm required.

Question 3

Part 3(a)(i) required used of uncertainty = 0.5 X range, and conversion to a percentage uncertainty.

Part 3(a)(ii) was slightly more demanding than 3(a) (i), requiring addition of percentage uncertainties. Some students lost marks by quoting too many significant figures.

In part 3(a)(iii) only the weakest students failed to realise that this was a random error.

For part 3(b) the first part was a straightforward calculation of percentage difference. Part (ii) was more demanding and discriminated well. Many students failed to realise the significance as to whether the uncertainty in the data could account for the difference in the predicted and measured gradient values. Explanations were generally poor and only the most able students produced satisfactory comments.

Question 4

Part 4(a) discriminated well. Ramps were the most common answer. To achieve credit for the ramp shape it must be curved with decreasing steepness so that the ball leaves the ramp horizontally.

Part 4(b) discriminated well with only the most able students able to achieve 3 or 4 marks. The marking points listed cover all the essential points in the process, and marks can only be awarded for these specific points.

In part 4(c) although relatively straightforward it was surprising that a significant proportion of students failed to understand what graph to plot to achieve a straight line through the origin.

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