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Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Physics (WPH16) Paper 1
Practical Skills in Physics II

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Introduction

The IAL paper WPH16 Practical Skills in Physics II assesses the skills associated with practical work in Physics and builds on the skills learned in the IAL paper WPH13. This paper assesses the skills of planning, data analysis and evaluation which are equivalent to those that A level Physics students in the UK are now assessed on within written examinations. This document should be read in conjunction with the question paper and the mark scheme which are available at the Pearson Qualifications website, along with Appendix 10 in the specification.

In this specification, it is expected that students will carry out a range of core practical experiments as the skills and techniques learned will be examined in this paper but not the core practical experiments themselves. Students who do little practical work will find this paper more difficult as many questions rely on applying the learning to novel as well as other standard experiments. It should be noted that, whilst much of the specification is equivalent to the previous specification, there are some notable differences. Students are expected to know and use terminology appropriately, and use standard techniques associated with analysing uncertainties, both of which are defined in Appendix 10. In addition, new command words may be used which to challenge the students to form conclusions. These are given in Appendix 9 of the specification.

The paper for October 2020 covered the same skills as in previous series and was therefore comparable overall in terms of demand. In addition, it appeared that whilst a number of students were well prepared for this examination, some were not capable of the basic skills expected of an A level student.

Question 1

This question was set in the context of using an air track to investigate the conservation of momentum and was therefore related to Core Practical 9. Overall, the students found this question difficult despite being aimed at the lower grades.

In part (a) students had to describe how to ensure the air track was horizontal which is a standard technique when using this piece of equipment. There were some very poor descriptions given even though a diagram of the apparatus was given to aid the students. In general, students either did not specify a piece of equipment to use or how it would be used. Some students referred to using set squares and rulers to check if the air track was perpendicular with the bench or floor rather than measuring the height in two places, to check whether the bench was horizontal, which suggested that they did not realise the height of the air track can be adjusted independently. A number of students tried to describe a spirit level without knowing the name. In addition, several students suggested putting a ball on the track, which suggested they had not seen an air track as it has a triangular profile.

Part (b) involved using the data to confirm whether momentum was conserved. This type of question has been used on a several occasions hence the students should have been familiar with this. Whilst a good number did what was expected and used the formula to predict a value, the main error was not comparing the calculated values with the expected values in their conclusion or not stating a conclusion at all. In addition, as this was a “show that” question students should use an appropriate number of significant figures. A significant number of students calculated mean values for the times. This was not a valid method as this was not a set of repeat values but three sets of independent data, however students could still gain some credit. Similarly, some students calculated a percentage difference which is not a valid method for comparing two measurements however some credit could still be given to these students. A small number of students did not use the data at all and derived the formula algebraically. It should be noted that where data is given in a question it should be used.

Part (c) included a new command word, assess, which requires students to consider the most important factors and form a judgment, in this case whether using a longer card would improve the experiment. Many students understood that the longer time would reduce the percentage uncertainty, however the vast majority of students did not use the factor of two stated in the question. Students tended to discuss in general terms that the percentage uncertainty would simply reduce without stating half. As with data, if the question states a number or factor then it should be used in the answer. In addition, very few candidates explained why this would occur, i.e. as the resolution of the timer or the uncertainty of the measurements would be same for both cards. It should be noted that use of the term “precision” was not accepted in place of the term “resolution” as this refers to the spread of data not the smallest interval of an instrument, however other equivalent terms would be accepted. A small number of students also referred to the increase in weight or air resistance, neither of which would be relevant in this experiment.

Question 2

This question assessed planning skills within the context of investigating the range of alpha particles in air and used the techniques associated with Core Practical 15 which many students seemed familiar with. This question used another new command word, devise. Students were expected to add more detail to an outline plan, such as identifying appropriate pieces of equipment or a range of measurements. It should be noted that outline plans may not be given in future series. As with previous series, this question resulted in a wide range of marks. Although marks were not awarded for linking ideas, students often suffered as their use of language was imprecise or their descriptions became muddled making their intentions unclear.

Many students stated that a background count rate should be taken before the experiment but often missed the mark by stating “measure background radiation”. Not all these students went on to state that this measurement should be subtracted from the count rate. Very few students realised that the first statement needed to be made clearer by stating that the source and tube should be in line. Many students realised that a rule or similar was needed to measure the distance, though not as many as expected. A suitable technique was required to measure the count rate, and many students realised that either a long period of time was needed, or the count rate should be repeated with a mean calculated. It was here that students were often not clear enough and it appeared that the distance not the count that should be repeated. Finally, a range of distance measurements was expected. Some students were able to do this, more often stating that the measurements should be repeated until the count reached the background count rate. There were a number of students who appeared to not know that alpha particles only travel a few centimetres in air, as distances up to a metre were suggested.

Students were also given extra credit for stating a graph to plot and for a suitable safety precaution. With the latter, many students still refer to personal protective equipment which is not appropriate, or stated the use of a lead-lined box but this should be for storage purposes. There were also a number of students who had clearly practised a different question as the use of different absorbers was also seen.

Question 3

This question involved an investigation using an oscillating magnet. Although this was a more novel experiment the techniques used were based on Core Practical 16.

Part (a) required students to describe the basic techniques used to measure the time period of the oscillations. This produced a wider range of marks than in previous series, presumably because of the more novel context. Some students appeared to focus on the use of the term angular displacement in the question stem as descriptions of the formula for angular velocity were seen. Students most often stated that a repeat measurement should be taken, but sometimes failed to state that a mean should be calculated. Similarly, many mentioned timing multiple oscillations, but did not go further to state dividing by the number of oscillations. A good number also described using a timing marker, but there were a few that were unclear about where the marker should be placed. As a departure from previous series, allowing the oscillations to settle was accepted as this is an appropriate technique to use.

Part (b) went further to include a circuit with a loop of wire, and a relationship between the time period of the oscillations and the current in the loop. In part (i) students had to identify an additional component that would be needed to test this relationship. This was poorly answered with many students stating a voltmeter. This suggests that students assumed an additional variable in the relationship or simply guessed as an ammeter was shown in the circuit. Part (ii) is a standard type of question used in most series, but more students did not gain the second mark as they did not state it would be a straight line, which is necessary to test the validity.

Part (c)(i) assessed the students' ability to process data and plot the correct graph. This is a question that appears in every paper therefore there is plenty of opportunity to practise this skill and to consult the associated mark scheme and Examiner's Reports to correct common errors. However, many students still find this problematic, particularly when negative numbers are used.

A good student should be able to access most of the marks but only a handful of graphs scoring full marks were seen. Many students processed the data correctly although there were some occasional errors in rounding or missing negative signs. The number of significant figures given should be sufficient to plot a graph on standard graph paper. For logarithms, the first figure is not significant, hence students should ideally give a four-figure number, for example 0.182, although if the range is larger three-figures may be sufficient.

The most common error in the graph was not labelling the *y*-axis in the correct form, i.e. log *I* or log *I* / A rather than log (*I* / A). Occasionally, ln values were calculated, which is acceptable, but the labels were still given as log. Some students also inverted the *y*-axis to avoid plotting negative numbers, and a few reversed the graph axes. In both cases this often led to issues with the gradient calculation. At this level, the students should be able to choose the most suitable scale in values of 1, 2, 5 and their multiples of 10 such that the plotted points occupy over half the grid in both directions. Students should realise that although the graph paper given in the question paper is a standard size the graph does not have to fill the grid, and a landscape graph can be used if it produces a more appropriate fit. Students should also be encouraged to label every major axis line, i.e. every 10 squares, with appropriate numbers. Occasionally students used an even scale, such as 0.5, but labelled the axes with numbers such as 0.24, 0.29 etc. which is unconventional. Students at this level should also realise that scales do not have to start from zero and scales based on 3, 4 (including 0.25) or 7 are not accepted.

Mis-plots were often seen therefore students should be taught to check a plot if it does not lie on the best fit line. Most students plotted the graph using neat crosses (× or +) and the use of these rather than dots should be encouraged. If a dot extends over half a small square, then this is not considered to be accurate plotting, and occasionally larger blobs were seen. The final value was intended to be an anomalous reading, therefore if this is not used to judge the best fit line then students should identify that data point as anomalous. Occasionally lines looked disjointed or did not extend across all data points, perhaps a result of using a ruler that is too small, or were too thick therefore did not gain this mark. It is recommended that students use a 30 cm ruler in this examination. Finally, students should be taught not to force a line through the origin or simply join the first and last points without judging the scatter of the points.

In part (c)(ii) the students had to use their graph to determine a value of n. It is expected that the gradient of the graph should be calculated, which the majority did well particularly those that labelled this on the graph. Those that used scales of 0.25, 0.3 or 0.4 were often only successful when sensible values were used. The triangle used should cover at least half of the plotted points and most did so. The main reasons for students not gaining full marks were not including a minus sign, using too few or too many significant figures, or including a unit which suggests that students do not understand that a logarithm is dimensionless.

Finally, the students had to justify the suggestion of a different relationship. This is a new command word where students should be giving evidence to support the statement. Many students scored some marks here, mostly for expanding the formula and noting that the graph had a non-zero y intercept. Often students did not state enough separate points for the number of marks available.

Question 4

This question focused on the analysis of uncertainties in the familiar context of a density measurement using a slotted mass, which is an object that should be familiar to the vast majority of students. In comparison to previous series, this question was worth more marks as it contained more analysis, however the question was structured and broken down into smaller parts. It should be noted that clear working is needed for this type of question as marks are awarded for the method, and the methods used follow those set out in Appendix 10 of the specification.

Part (a) allowed the students to demonstrate their understanding of measuring length and width by identifying the most suitable apparatus to measure the slot, and explaining a measuring technique. The diagram appeared not to help some students as they chose a micrometer or ruler as being appropriate. Whilst many students described a suitable technique, a good portion of these did not explain why it is used. In some cases, two techniques were described suggesting that the student misunderstood the meaning of the command word "explain".

The rest of the question focused on the analysis of the measurements. In part (a)(iii) the students had to calculate the area of the slot with its uncertainty. Whilst the vast majority calculated the area correctly, as it is a simple calculation, too many significant figures caused many to lose the mark. The uncertainty calculation caused a few problems with some students simply adding the uncertainties together, which is not valid for measurements that are multiplied together. In addition, some students stated the percentage uncertainty rather than uncertainty. It was expected that the number of decimal places should match that of the measurement.

In part (b) the student had to calculate the total area of the metal and its uncertainty. It was surprising how many students did not manage to calculate the area of a circle correctly, or not use the stated value of the diameter. Where students were successful in this, they rarely failed to subtract the areas of the slot but often used too many significant figures. Here, three significant figures was more appropriate. The calculation of the uncertainty was more involved and only a few were relatively successful in this. Whilst a good number had the correct method for calculating the percentage uncertainty in the total area, some did not use half the resolution suggested by the value of the diameter. In addition, many went on to combine the percentage uncertainties rather than add the absolute uncertainties which is the valid method for values that are subtracted.

In part (c) students had to calculate the density and its percentage uncertainty. The density calculation was more problematic than expected as many either ignored the thickness value or calculated the volume of a sphere. Where students were successful, the number of significant figures was appropriate more often. The uncertainty calculation was where students often scored well provided their working was clear. The majority used the half range of the thickness to calculate the percentage uncertainty, however a number still used the whole range and some appeared to use the resolution. Those that then added the percentage uncertainty in their area could score the rest of the marks. However, it was not uncommon to see students include additional percentage uncertainties from the entire question.

Finally, the students had to use this percentage uncertainty to determine whether the metal could be brass. This was much more familiar to the students and a good number scored well. The more successful method is to calculate an upper and lower limit as more mistakes can occur with the percentage difference method, namely the denominator not being the quoted value. As in previous series, the main error with the conclusion was not explicitly making a comparison between values.

Summary

Students will be more successful if they routinely carry out and plan practical activities for themselves using a wide variety of techniques. These can be simple experiments that do not require expensive, specialist equipment. In particular, they should make measurements on simple objects using vernier calipers and micrometers, and complete all the core practical experiments given in the specification.

In addition, the following advice should help to improve the performance on this paper.

- Learn what is expected from different command words, in particular the difference between describe and explain.
- Use the number of marks available to judge the number of separate points required in the answer.
- Be able to describe different measuring techniques in different contexts and explain the reason for using them.
- Show working in all calculations as many questions rely on answers from another part in the question, or marks are awarded for the method used.
- Be consistent with the use of significant figures. Quantities derived from measurements should not contain more significant figures than the data and percentage uncertainties should be given to at least one fewer significant figure than the derived quantity.
- Choose graph scales that are sensible, i.e. 1, 2 or 5 and their powers of ten only so that at least half the page is used. It is not necessary to use the entire grid if this results in an awkward scale, i,e. in 3, 4 or 7. Grids can be used in landscape if that gives a more sensible scale.
- Use a sharp pencil to plot data using neat crosses (× or +), and to draw best fit lines. Avoid simply joining the first and last data points, or forcing the line through the origin.
- Draw a large triangle on graphs using sensible points. Labelling the triangle often avoids mistakes in data extraction.
- Learn the definitions of the terms used in practical work and standard techniques for analysing uncertainties. These are given in Appendix 10 of the new IAL specification.
- Revise the content of WPH13 as this paper builds on the knowledge from AS.

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