Examiners' Report
Principal Examiner Feedback

January 2021

Pearson Edexcel International Advanced Subsidiary Level
In Physics (WPH13)
Paper 01 Practical Skills in Physics I

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Introduction

The Pearson Edexcel International AS-level paper WPH13, Practical Skills in Physics I is worth 50 marks and consists of four questions, which enables students of all abilities to apply their knowledge and skills to a variety of styles of question.

Each question assesses the student's knowledge and understanding of the skills developed while completing practical investigations.

Students' understanding of the 8 core practical tasks will be assessed by the WPH11 and WPH12 papers. As such, the practical contexts met in the WPH13 paper may be less familiar but are similar to practical investigations students may complete during their AS Physics studies. The scenarios outlined will be related to content taught during the study of WPH11 and WPH12.

However, the focus of WPH13 is the assessment of the practical skills the students have developed, as applied to the physics context described in the question.

There will be questions that are familiar for students who have revised using the earlier series of WPH03 and WPH13 papers, but some performances would suggest a handful of students were unfamiliar with the practical skills outlined in the specification for Unit 3.

At all ability levels, there were some questions which students answered with generic and pre-learned responses, rather than being specific to the particular scenario as described in the question. Additionally, understanding the meaning of the standard command words (such as justify and criticise) proved a challenge to students at the lower end of the ability range.

Question 1 (a)

This question introduced a typical practical approach used when investigating the relationship between the acceleration of an object and the resultant force applied to the object. Students were asked to describe how the acceleration could be determined using the equipment shown.

Most candidates gave clear descriptions of the measurements to be taken and the analysis of the data that would allow the acceleration value to be determined. Some did not include details, such as repeating and calculating the mean or naming the equipment to be used.

There was a small proportion of students who suggested using the same relationship that was being investigated ($F=ma$) to calculate acceleration using the weight of the slotted masses. But that approach assumes no friction and did not include the mass of the slotted masses as also being accelerated.

Question 1 (b)

1(b)(i)

This question required students to correctly plot two data points, for 1 mark, meeting the standard criteria (plots correct to within 1 mm).

This was followed up by adding a line of best fit. The data shows a slight curve, but a straight line of best fit could be drawn. This would clearly not pass through the origin.

Many students ignored the trend of the point and forced their line through the origin. Although we would expect a directly proportional relationship between force and acceleration, for WPH13 students should also be aware that a systematic error can cause a positive or negative y-axis intercept to be seen.

Other students simply joined two plots together, ignoring any balancing of the number and distances of the plots above and below the line.

1(b)(ii)

It was clear that many students did not read this question carefully, as the information given in the question is that the student's results "do **not** show that the acceleration... is directly proportional to the force". It was common to see contradictions in the answers given. For example, "The straight line passes through the origin, therefore the student is correct".

Question 1 (c)

Although the practical outlined in question 1 is commonly used to investigate *F=ma* while studying physics in earlier years, this part of the question asks the student how the systematic error seen in 1(b) can be reduced.

In this case, the systematic error is caused by the total mass of the system changing as the mass of the slotted masses was increased.

In the specification, section 3.4, students are expected to be able to comment on how an experiment could be improved.

There was a clear disparity between those students who understood the source of the systematic error (perhaps having carried out the practical themselves) and those who treated this as a random error, so suggesting a simple repeat-and-mean approach.

Question 2 (a)

This question required students to measure the critical angle from the diagram. This value is then used to calculate the refractive index of the transparent material.

As students were measuring the angle to the normal they drew, some lee-way was allowed in the angle measured and the refractive index calculated.

Most students completed this well and scored all 3 marks. However, many did not identify the critical angle correctly (WPH12), so scored only 1 mark for the use of the equation.

Question 2 (b)

Here students were asked to use the uncertainty in the critical angle measurement to consider the range of the values of the refractive index caused by this uncertainty.

This skill was tested in previous WPH13 papers. As the sine function is not linear, students cannot simply use percentage uncertainty. In this situation, students need to calculate using the maximum and minimum values of the critical angle.

Again, most students scored full marks, but a surprising number simply gave the range of the critical angle. Others ignored the sine function in the equation and used $n = 1/C$.

Question 2 (c)

As with 2 (b), most scored full marks. However, three main issues were seen.

Some students re-used the critical angle equation (as used in 2 (a) and 2 (b)).

Others used $n_1 \sin \theta_1 = n_2 \sin \theta_2$, but incorrectly substituted n_2 as 1.
Both of these errors still allowed some marks to be awarded.

The third issue seen affected the final mark. Students were asked to compare this block to the block in 2 (b). Some students compared to the block in 2 (a).

Question 2 (d)

This question was set at a high demand level.

Students needed to link the idea of having a single wavelength (in comparison to the white light from a ray box) to their recall from WPH12 that the angle of refraction (and so the refractive index) changes with wavelength.

Most students struggled to move beyond the idea that monochromatic light had a single wavelength. Many failed to link wavelength to the angle of refraction and it was rare for this to be linked to improved accuracy or smaller uncertainty in either angle of refraction or refractive index.

The idea of monochromatic light, and how this can improve accuracy, has been tested before in WPH13.

Question 2 (e)

Although it is highly likely many students have not seen or used a spectrometer, all the relevant information required was summarised in the three sentences below the photograph.

The command word justify requires the students to give evidence to support the statement.

Two facts were given, narrow parallel beam and resolution of 0.1˚, that can be used to justify a reduced uncertainty in the refractive index if using a spectrometer compared to a ray box and protractor.

Students simply needed to add more detail to give the evidence, e.g. compare the resolution of the spectrometer to the resolution of the protractor, compare the narrow parallel beam to the wide and spreading beam typical of a ray box.

Both could then be used to justify a more accurate measurement of angles (the critical angle if considering 2 (a) and 2 (b), or the angles of incidence and refraction if considering 2 (c)).

Question 3 (a)

As with 1 (a), this part of question 3 is a planning exercise. As such, students were expected to describe with a diagram the method and equipment used to acquire force and extension data. Most did this well, though some students did not fully describe the process (vague statements e.g. “measure the extension”) or did not name, or draw key equipment.

When describing the use of equipment, students should be considering how the equipment should be used to give accurate data. It was this final mark that was most often not awarded.

Question 3 (b)

This question tested the students' ability to estimate an area under the curve of a graph and to understand the significance of this area. (Mathematical Skills C.3.8)

From WPH12, students should recall elastic strain energy can be calculated from the areas under a force-extension graph, for both linear and non-linear graphs.

As the energy transferred to the internal energy store is the difference between the work done *on* the rubber band when stretching (loading) and the work done *by* the rubber band when contracting (unloading), students had 2 possible approaches.

They could estimate the area under both curves and subtract the values, or the area of the loop could be estimated.

The area could be estimated by counting squares and multiplying by the area (work) for one square. Alternatively, students split the areas into triangles, rectangles and trapezia.

This question differentiated between students, with those confident in the mathematical skills required performing this task very well. However, a large number of students simply left this part of the question blank.

Question 4 (a)

The specification for WPH13 clearly states in section 3.5 that student should be able to calcualted the percentage uncertainty for a single reading using **half** the resolution of the device.

The device shown has a resolution of 0.5 V, so the uncertainty would be ±0.25 V and a value shown of 10.5 V giving a percentage uncertainty of 2.4%.

The vast majority of students gave an answer of 4.8%, having used ±0.5 V as the uncertainty.

Question 4 (b)

This question tested student ability to plan an experiment, particularly the ability to justify a choice of a measuring intrustrument by considering errors and uncertainty.

Most candidates performed well, though may have missed the fact "Discuss the advantages" was plural, as many only linked one feature of the digital multimeter to the idea of reduced uncertainty in the potential difference value.

The command word "discuss" requires students to investigate the situation by reasoning and explore all aspects of the situation.

Question 5 (a)

This type of question has appeared in many previous WPH13 papers (and WPH03 papers from the previous IAL AS qualification). As before, most students performed well.

Some did not link their answers sufficiently to the data. For example, a simple statement of "inconsistent significant figures" is not clear, as there is a inconssitency between temperature and resistance data, as well as the inconsistency for 2 resistance values.

A small number of students gave lists of irrelevant answers, that seem to be memorised answers to previous papers. These were ignored.

Question 5 (b) & (c)

As in earlier series for this paper the same common mistakes were seen.

- Missing/incorrect units for axis labels – axes need complete labels, with unit given **using a forward slash symbol**, e.g. temperature / ˚C.
- Unusual scale choices – scales should be a factor of 1, 2 or 5 on the 2 cm lines. For this paper, it was common to see *y*-axis scales starting a 0, which meant the graph.
- The mark given for choosing a scale required that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.
- Inaccurate plotting – plots should be small and neat, so plotting can be checked and shown to be within 1 mm of the correct position. For WPH13, there are 2 marks available for plotting.
- Unbalanced/uneven lines of best fit – for this paper, many lines of best fit ignored the second point (so were too low)

Earlier series for this paper would often split the gradient calculation and a calculation of a corresponding constant from the equation into 2 part-questions. Here the analysis was combined into a single 6 mark question.

For this paper, students were given the equation arranged into a $y = mx + c$ format. By considering the equation, students could identify that

- R_0 could be determined by extending the line to the *y*-axis intercept
- α could be determined using the gradient and R_0

Some students, generally those with higher level mathematics ability, used simultaneous equations for 2 sets of R and θ values from the graph. This was credited as a correct alternative to using the *y*-axis intercept and gradient of the line.

It was common to see a unit error for α, with students failing to consider the gradient as having a unit (Ω ˚C^{-1}).

Question 5 (d)

Explaining how to modify an investigation in a way that inproves accuracy remains a challenge to students, but this is specified in section 3.5 of the specification for WPH13.

In this example, most students scored 1 mark for stating a suitable modification, but this was rarely explained in sufficient detail. For example, it was common to see “to make the line of best fit better”

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