Examiners' Report
Principal Examiner Feedback

January 2024

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

Introduction

The Pearson Edexcel International AS-level paper WPH13, Practical Skills in Physics I is worth 50 marks and consists of four questions, which enable 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.

A student's 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, during the completion of the required core practical tasks and other experiments, as applied to the physics context described in the question.

There will be questions that are familiar to students who have revised using the earlier series of WPH03 and WPH13 papers, but some performances would suggest some students were unfamiliar with the practical skills outlined in the specification for Unit 3. A particular issue commonly seen related to the uncertainty in measured data and the calculation of percentage uncertainty.

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 evaluate and determine) proved a challenge to students at the lower end of the ability range.

Question 1(a)

Appendix 10 of the physics specification defines resolution to be "the smallest measuring interval and source of uncertainty in a single reading".

For this question, in (a)(i) students were required to recognise the smallest measuring interval in the balance display shown was 0.001 kg. One common error seen was to state the uncertainty, not the resolution. Another common error was not providing the unit.

In (a)(ii), students were asked to determine the percentage uncertainty in the value shown. Appendix 10 suggests that for digital instruments, such as this balance, the uncertainty would be half the resolution (0.0005 kg). Students who correctly calculated the percentage of the full resolution (0.001 kg) were rewarded with 1 mark.

Question 1(b)

Most students described the **standard** technique "repeat measurement in different positions and orientations, and calculate the mean". We did accept this, although measurements in different orientations would not be relevant this time.

Some did describe checking for zero error or being careful not to overtighten the jaws.

However, most did not attempt to **explain** the technique, giving no link to the type of error reduced.

Question 1(c)

In (c)(i) students were required to use the mass measurement (in kg) and the dimensions of the paper stack (in mm), to determine the density in g cm^{-3}. As such, it was common to see **powers of ten** errors in the final answer.

It was remarkably common for students to also include the factor of 500 (the number of sheets of paper in the stack). In most of these, the students divided their correct value of density by 500, leading to an incorrect final answer.

Question 2(a)

The diagram shows a battery, a switch and a motor. To determine the power of the motor, students also needed an ammeter and voltmeter. All five components were required for the first mark point to be awarded.

It was common to see additional components such as a variable resistor. These were ignored for the first mark point.

However the addition of components in series, with a resistance and potential difference, would mean the voltmeter must only connect to the motor. So, the additional resistors did mean some students were not awarded the second mark point.

A significant number of students did not include an ammeter or voltmeter, so scored zero marks.

Question 2(b)

In (b)(i) students were asked to describe how to measure a single value of **height** gained as accurately as possible.

This was commonly misinterpreted, with answers including light gates (to determine accurate values of time) or methods outlining repeat readings - which is tested in (b)(ii).

As such, most students were awarded 1 mark for some description of measuring perpendicular to the metre rule scale, eg "take the measurement of height at eye-level". It was also common to see "make sure the metre rule is vertical using a set-square", giving a 2-mark answer.

Very few students considered clamping the metre rule or described where to measure the height from.

Question 2(c)

As the formulas for efficiency are given in the formula list

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

there is no credit for simply stating either of these equations.

As such, the third marking point (the efficiency calculation) was dependent on students defining **both** the total power (or energy) input **and** useful power (or energy) output.

It was common to see generic statements, rather than explanations. It was also common to see confusion between energy and power, eg "the power input is P=VI, and the power output is E=mgh".

Question 3(a)

WPH13 cannot assess a student's recall of the core practicals completed during WPH11 and WPH12 studies. However, we can test a student's application of the knowledge and skills obtained, as applied to a different experiment.

Core Practical 6 requires students to use a laser or other light source, and a diffraction grating to determine the wavelength of light. As such, students will have experienced the use of a laser (or other high-intensity light source) in a darkened environment.

So, the concept of damage/irritation to the eye or of dazzling the student should be familiar, and most students scored this mark.

It was common for students to give the **standard** response "wear safety goggles". However, in this scenario, safety goggles that were not tinted would not be useful.

Question 3(b)

While completing Core Practical 6, students would have made measurements of the distance between maxima. Here, students were asked to describe how to determine an accurate value for the distance between adjacent minima.

Most students did not identify the need to measure from the centre of the dark areas (the centre of each minima), so very few students were awarded the first mark.

It was common to see generic statements to "repeat the measurements and calculate the mean". However, such statements were not rewarded the second mark if the answer did not make it clear that the repeats were different pairs of adjacent minima. As such, most students did not score a mark.

Although the question refers to using the metre rule to measure between adjacent minima, we did credit answers which used multiple minima to determine the average distance between adjacent minima. Some students did describe dividing by the number of minima, rather than the number of gaps between minima (number of maxima), but we gave these students the benefit of doubt.

Question 3(c)

3(c)(i) asks students to perform a standard calculation, to determine the mean of 3 values.

No single value stands out as an anomaly, though it was relatively common to see students discount the 84.4 value. These students were awarded the first mark only.

As all 3 values in the data were rounded to 3 significant figures, the resulting mean should also be rounded to 3 significant figures.

For (c)(ii), students were asked to determine the percentage uncertainty in this mean. In As with 1(a)(ii), appendix 10 outlines two acceptable approaches to calculate the uncertainty.

- Uncertainty is equal to half the range of values
- Uncertainty is equal to the difference between the mean and the furthest value from the mean.

Both approaches were rewarded. For students who discounted one value in (c)(i), error carried forward was applied for both the range and mean value in (c)(ii).

Question 3(d)

Deduce questions, such as this one, appear regularly on WPH13 and WPH16 papers.

In this case, students needed to demonstrate whether the value of breaking stress for copper wire was within the 6% uncertainty range for the hair.

Most students performed this calculation well and made a clear comparison to support their conclusion, being rewarded with 2 marks. Some students did not include a comparison when writing their conclusion, so scored the first mark only.

Question 4(a)

The scenario described in this question may be unfamiliar to students. However, the measurement of distance *d* is very similar to the measurements required in Core Practical 4.

There the sensor is a microphone and the filament bulb is a loudspeaker. But, in both there is parallax error when measuring distance *d* using the metre rule. In both, there is difficulty measuring to the starting point (the enclosed filament or the recessed speaker cone). For this scenario, we also have the effect of external / background light sources.

Students were asked to explain how two sources of error can be reduced. It was common to see only 1 source, with the parallax option being seen most often.

Answers often lacked detail. The command word for this question was explain, but answers were often too vague to be awarded the first mark point. Answers such as “there is parallax error, so ensure eyes are perpendicular when taking measurements” were common, scoring only the second mark as the parallax error was not linked to the measurement of *d*.

Question 4(b)(i)

Students are generally well-practised with this type of question. Often these questions ask students to link a quantity in the formula to the gradient.

However, this question asks students to demonstrate that the line is straight and passes through the origin. To do this, students needed to demonstrate that the gradient was linked to a constant.

If students compared their re-arranged formula to the standard equation for a straight line through the origin ($y = mx$), they only needed to demonstrate that m was a constant. This approach saw more students being awarded 2 marks. But many students scored only 1 mark, as they correctly linked the gradient to k, but did not state that the gradient was a constant.

Some students used the standard comparison with the equation for **any** straight line ($y = mx + c$). These students also needed to **show** that there was no y-axis intercept value, by stating that $c = 0$. As such, students who took the second approach were more likely to be awarded only 1 mark.

Question 4(b)(ii)

In both WPH13 and WPH16, there are marks for processing the data in preparation for plotting the graph. Students are expected to correctly round their values, to match the number of significant figures in the provided data. In this case, students were asked to calculate $1/d^2$ values, and were expected to round their values to 3 significant figures (to match the d values)

Completing both parts of this task is usually awarded 1 mark. But with 6 values to calculate, students were awarded 2 marks, with the correct rounding awarded its own mark.

As such, most students were awarded at least 1 mark. Other than incorrectly rounding, the most common error was to misread $1/d^2$ as I/d^2.

Question 4(b)(iii)

Graphs remain a challenge to students, but this is one area where a little more time spent on practice would significantly benefit students.

There are 5 marks available for plotting a graph on WPH13. This makes up 10% of the marks available, so a well-drawn graph could increase a student's achievement by a grade.

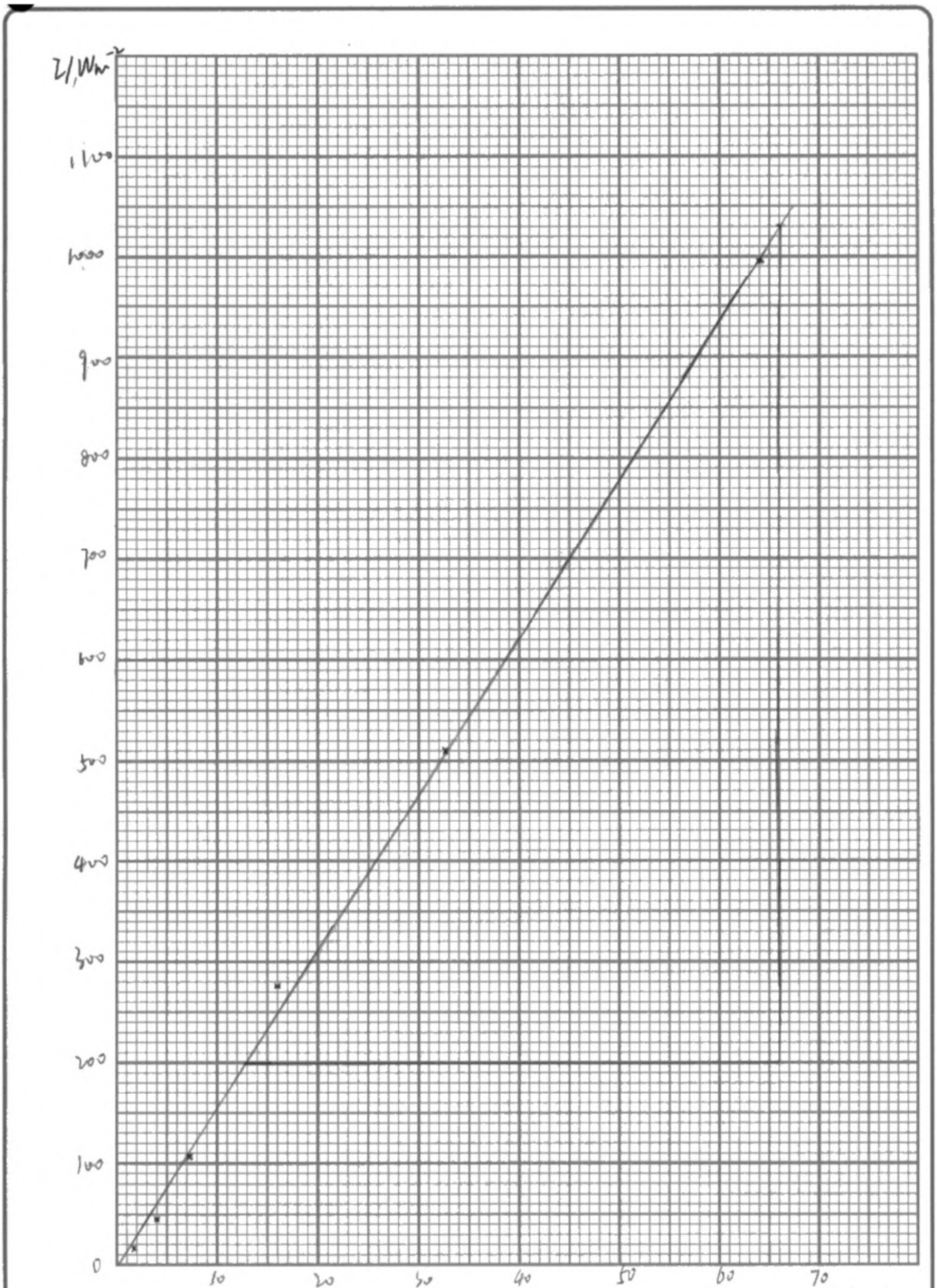
The standard expectations of a well-drawn graph are:

- Labelled axes – the quantity **and** unit separated by a **/**
  eg I / W m^{-2} and $1/d^2$ / m^{-2}
- Scales chosen that maximise the size of the used portion of the graph, while still being an easily interpreted scale. The graph paper provided is divided into 10 small squares every 2 cm, so we expect a scale with increments **on the 2 cm** lines that go up in **1, 2 or 5** if we ignore powers of 10.

  eg on the *y*-axis increments of 100 W m^{-2} every 2 cm and on the *x*-axis increments of 10 m^{-2} every 2 cm

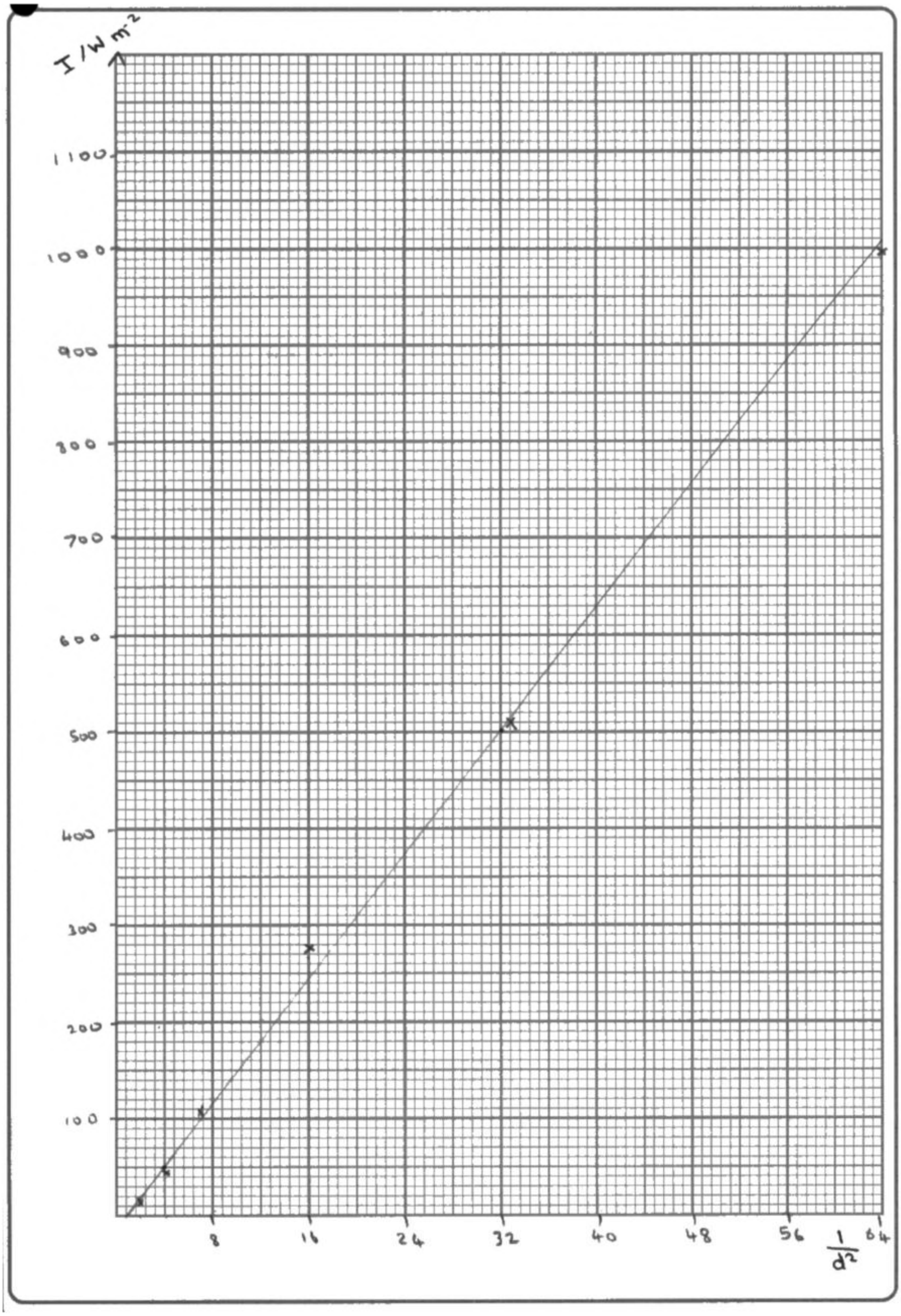
  NOTE – with $1/d^2$ values of 4.00, 16.0 and 64.0 it was common to see students use increments of 8 m^{-2} every 2 cm. This is unsuitable and causes plotting errors (particulary 7.11 and 32.7)
- Data points that are plotted accurately to **within 1 mm** (half a square) in both directions. This means large or unclear plots cannot be checked for accuracy, eg students should be advised that **large bullet-point style plots** will not be credited.). Small neat plots (eg $\times$) are expected.
- A well-balanced line of best fit that follows closely the trend of the plots. This includes any incorrect plot students may have assumed was an anomaly, if that plot has not been marked as an anomaly to be disregarded.

The example meets all the expected standards, so this student was awarded all 5 marks.



The example scored only 1 mark for the line of best fit.
The following errors can be seen.

- The *x*-axis label is missing the unit
- The *x*-axis scale is unsuitable – it goes up in increments of 8 every 2 cm



Question 4(b)(iv)

Most students are well-practiced when it comes to determining the gradient of a graph. However, it is still common to see gradient ranges that cover less than half the line (not using a "large triangle" when calculating the gradient).

The graph values (including scale and subdivisions) would be 2 or 3 significant figures on the x-axis (depending on the scale choice), so the gradient should be rounded to the same number of significant figures.

This example scores 3 marks.

- The gradient triangle covers more than half the line
  It is best practice for students to draw the triangle.
  You can see this trianle drawn on the first example of the (b)(iii) graph
- The value is within the range
- The value is correctly rounded and the correct unit is given

(iv) Determine the value of k from the graph.

(3)

$k = \frac{1030 - 200}{66 - 13} = 15.66 \approx 15.7$ W

$k =$ 15.7 W

The second example uses a range of 32 to 4 on the *x*-axis.
32 is half-way along the axis, so 32 to 4 is less than half.
The value is incorrectly rounded and has no unit.
However, the value is within range – so 1 mark can be awarded.

(iv) Determine the value of k from the graph.

(3)

gradient $= \frac{500 - 50}{32 - 4} = 16.07 = 16.07$ W

gradient $= \frac{I}{1/d^2} = Id^2$ $\quad I = \frac{k}{d^2}$ $\quad K = Id^2$ $\quad K = 16.07$ W

$k =$ 16.07

Question 4(b)(v)

An intensity of 4 or 8 W m^{-2} is too small for students to use the graph to determine *d* directly.

Students determined a value for *k* in (b)(iv), so could substitute this into the equation provided at the start of (b).

Most students completed this successfully and most students were awarded at least 1 mark.

Very few students were awarded both marks.

Many students did not correct the intensity I, by subtracting the background intensity. Others calculated two values of distance (using I = 8 W m^{-2} and I = 4 W m^{-2}) and subtracted those. A significant minority forgot to square root their d^2 value.