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Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level in Physics (WPH16)
Paper 01 Practical Skills in Physics II

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General

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 candidates in the UK are 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 Unit 6 and Appendix 10 in the specification.

In this specification, it is expected that candidates will carry out a range of Core Practical experiments. The skills and techniques learned from carrying out these experiments will be examined in this paper, but the Core Practical experiments themselves are not assessed. Candidates 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.

Candidates are expected to know and use terminology appropriately, and use standard techniques associated with analysing uncertainties. These can be found in Appendix 10 of the specification. In addition, command words may be used which to challenge the candidates to form conclusions. These are given in Appendix 9 of the specification, and centres should make sure that candidates understand what the command words mean.

The paper for January 2025 covered the same skills as in previous series and was therefore similar in demand.

Question 1

This question was set in the context of investigating the pressure of a sample of air at varying temperatures. This investigation shares some features with Core Practical 12: Thermistor.

In part (a) candidates had to **identify one** health and safety issue for the investigation **and** how it should be dealt with. At this level, safety precautions should be **specific** to the investigation being described. In addition, general comments such as students being "hurt" are not accepted. Most candidates focused on the risks associated with heating. The most common errors were referring to gloves or safety gloves, rather than insulated or heat-resistant gloves, or using gloves to protect against electric shock. Students also needed to refer to **what** would be hot or **what** would cause burns. Some candidates discussed electrical safety which was not accepted in this context as the electrical connections were clearly outside of the water.

In part (b) candidates had to **describe** a method to determine the temperature of the air inside the flask. Some candidates did not appreciate that this involved a measurement of temperature as they tried to use the formula $pV = NkT$. The first mark was for identifying the apparatus needed. At this level, candidates should be able to name common instruments as some referred to a "gauge" or "temperature meter" rather than a thermometer. Some candidates did not mention an instrument at all, which suggests that they did not check the diagram fully. In some cases, candidates referred to measuring the temperature of the air instead of the water which was not accepted. The second mark was for the placement of the thermometer, either close to the flask or away from the heater, which was awarded less frequently. Occasionally candidates placed the thermometer close to the beaker which was not accepted. It appeared that some candidates had not appreciated that the flask was sealed as they considered placing a thermometer inside the flask. The final mark was for a technique in ensuring accuracy and the most common response was to stir the water. Some did state to read the scale perpendicularly, but the usual errors occurred here, such as using words such as parallel and horizontal. Repeating and calculating a mean is not a valid technique for this type of investigation. Some candidates referred to modifications to reduce energy dissipation, which, although good practice, is not a technique.

Part (c) involved the analysis of a set of temperature measurements. In part (i) candidates had to **determine** a mean value of the temperature from the set of data. Note that candidates are not expected to identify and remove "anomalous" data. In addition, candidates are expected to give the correct value of the mean to the **same number of decimal places as the data**. Some candidates gave too many decimal places or omitted the unit.

Part (c)(ii) involved **determining** the percentage uncertainty in the mean value. There were very few candidates that did not attempt this question. Candidates **must show** the calculation for the first mark, and this is awarded for using the **correct half range or furthest from the mean**. Occasionally, candidates used what appeared to be a resolution or the full range and neither are accepted. The final mark was for the correct percentage uncertainty given to one or two significant figures. Often candidates gave three or more significant figures and occasionally the % sign was omitted.

In part (c)(iii) candidates had to use the mean temperature to **determine** the number of air molecules in the flask. Most candidates gave correct answers to an appropriate number of significant figures. The most common reasons for not scoring full marks were incorrect conversions of units or incorrect calculation of volume. Occasionally candidates did not convert temperature from °C to Kelvin or used 271 rather than 273. In addition, some did not convert diameter into metres. The calculation of volume was more problematic as some used the diameter rather than the radius or incorrectly recalled the formula for the volume of a sphere.

Question 2

This question assessed planning skills within the context of investigating how the brightness of a filament bulb depended on the power input. The use of electrical circuits can be found in several core practicals.

In part (a) candidates were required to **complete** the circuit diagram which could be used in the investigation. Most circuits were drawn correctly, but the most common error was not including a variable resistor. At this level, candidates should use standard symbols for electrical components. Too often candidates did not draw the correct symbol for a variable resistor, either by missing off an arrowhead, drawing a thermistor symbol or combining the two. Occasionally, candidates missed out a suitable power supply. The second mark was for including an ammeter and voltmeter in the correct position for this investigation. It was pleasing to see that most candidates included both an ammeter and voltmeter but occasionally one or both were missing. In addition, some candidates placed the voltmeter in series, or in parallel with the power supply or another component.

Part (b) was the familiar planning question where candidates should be aiming to **devise** a method for the investigation described in the question that could be followed by a competent physicist. Many candidates answered this question well as the mark scheme for this type of the question follows a similar structure in each series. Although marks were not awarded for linking ideas, candidates using vague language or not describing a method logically can lead to marks not being awarded. The best answers were structured and concise, leading to a method that could be followed easily. Those candidates that started by analysing the formula often scored well.

The first mark was for **identifying the control variable** for this investigation, i.e. the distance between the bulb and the sensor. This was scored less often. Some candidates realised that the distance would be a factor as they stated that it should be measured, but this was not enough to suggest that the bulb and sensor would remain in the same position. This also suggested that they were confusing this experiment with an inverse square investigation. Some also referred to “changing the orientation” of the sensor without including any detail on how this may affect the alignment of the sensor, so this was not credited.

The second mark was for **identifying a source of error** in the investigation and this mark was scored the least. Only a few candidates stated that sources of additional light would affect the readings. Where this mark was scored, it was often for a statement regarding using a dark room or a suitable method to remove systematic error.

The third mark was for **identifying the measurements** needed to calculate the power input to the filament bulb, and the fourth mark was for **describing how to use the measurements** to obtain a value for the power input. It was rare to see candidates not being awarded these marks unless they did not mention an ammeter and voltmeter at all.

The fifth mark was for stating how to obtain **sufficient and valid data** to plot the graph for this investigation. Some candidates were too vague in their descriptions as it was unclear whether they were repeating the measurements five times to calculate a mean, i.e. at the same value of power, or measuring at five **different** values of power to plot a graph. Another common error included stating “many values” instead of stating how many. Those that confused this experiment with an inverse square law could not access this mark.

The final mark was for stating the **graph to plot** and how to use it to **test the prediction**. Most candidates were confident in which graph to plot, but explaining how to use the graph was expressed less well. Some candidates stated what the graph **will be** instead of the idea of **checking** which was not accepted. Common errors included phrases such as “it **will** be a straight line” or “the gradient **will** be 4” for a log-log plot. Occasionally candidates missed this out altogether.

Question 3

This question involved plotting and analysing the graph of the amplitude of a damped pendulum. A question involving a graph appears in each series therefore there are plenty of opportunities to practise this skill and consult Examiner’s Reports to correct common errors.

Part (a) was based on discussing the **sources of error** in the measurement of the amplitude. This was not answered well. Many candidates focused on the resolution of the metre rule instead of the practical difficulties of measuring the amplitude. The first mark was for appreciating that it would be difficult to judge when the pendulum was at its maximum displacement owing to the motion of the pendulum. Although some appreciated that the pendulum would be moving, very few identified that it would be changing direction quickly at the point of maximum displacement. Another common error was to state that the amplitude would be constantly changing rather than the displacement of the pendulum. The second mark was for identifying that there would be a parallax error in the measurement and this mark was more commonly awarded. Some candidates noted the distance between the cone and the metre rule or described the difficulty in ensuring a perpendicular line of sight at the right moment.

In part (b) candidates were presented with the relationship $A = A_0 e^{-\lambda n}$ which describes how the amplitude of a damped pendulum varies with the number of oscillations. In part (i) candidates had to **explain** how a graph of ln *A* against *n* could be used to determine the value of the constant λ. This type of question should be very familiar however there may a slightly different emphasis that candidates should be aware of. The first mark was for performing a **correct log expansion** of the given formula. There are only two forms this can take, either a power law such or an exponential function such as this. However, some candidates did not complete this successfully. For the second mark candidates must make two statements. Firstly, candidates must **compare** their log expansion with *y* = *mx* + *c*, which is standard for this type of question. The comparison must be **explicit**, i.e. the order of the log expansion **must match** the order of terms of the equation of a straight line. It should be noted that where two forms of the expansion are given, it is usually the final one that is used as the comparison. In some cases, candidates used arrows and missed out the + and = which was not credited. Secondly candidates had to **identify the gradient** correctly as $-\lambda$. Some referred to "*m*" or relied on a loop or arrow rather than state "the gradient is" which is not accepted. As this is an "explain" question, this must be explicit. Occasionally, candidates omitted the – sign.

Part (b)(ii) assessed the candidates' ability to process data and plot the graph of ln *A* against *n*. The mark scheme follows the same format for each series. The first mark was for **processing the data correctly**. It is expected that candidates use natural logarithms for an exponential law, however some candidates gave values to base 10 which was not accepted. Other errors included dividing ln *A* by *n* or not using logarithms at all. To gain these marks, the values must be **correct** and given to a **consistent number of decimal**

places sufficient to plot a graph accurately on standard graph paper. For logarithms candidates should give **three decimal places** although two can be accepted if the range is sufficient for the graph. The most common errors here were truncating rather than rounding, double rounding and using one decimal place. Most candidates realised that it was unnecessary to convert amplitude to metres.

The second mark was for **placing the axes the correct way around and labelling with the correct quantity and unit**. Some candidates reversed the axes, i.e., they plotted n against ln A. Candidates should note that the question is always written in the form "plot y against x". This also often lead to mistakes in later parts. The most common error is not using the correct format for labelling a log axis, either by missing out the brackets or units or both. The correct form is log (quantity/unit), e.g. ln (A / cm) not ln A / cm or ln A. A few candidates did not label their axes at all. A small number of candidates plotted the incorrect graph or plotted the raw data.

The third mark was for **choosing an appropriate scale**. At this level, the candidates should be able to choose the most suitable scale in **values of 1, 2, 5 and their multiples of 10** such that **all** the plotted points occupy **over half the grid in both directions**. Candidates should note that, although the graph paper given in the question paper is a standard size, the graph does not have to fill the whole grid and using the grid in landscape is often unnecessary. Candidates at this level should also realise that **scales based on 3, 4 (including 0.25) or 7 are awkward and not accepted**. Candidates should also label every major axis line, i.e. every 10 small squares, with appropriate numbers, so that examiners can easily see the scale used. The most common error was including a zero on the y axis so that the scale was too small or using a y scale of 0.25 which is awkward.

The fourth mark is for **accurate plotting**. Candidates should use **neat crosses** (× or +) rather than dots when plotting points. Candidates were not awarded this mark if they used large dots that extended over a small square or used an awkward scale. Misplots were less common in this series as it was a log-linear plot, however candidates should check a plot if it lies far from the best fit line.

The final mark is for drawing a **reasonable best-fit line** and was awarded often. When drawing a best-fit line, candidates will often join the first and last points instead of judging the scatter of the data points, which may not be credited. Candidates should ensure there are plots on both sides of the line and that the line cannot be rotated, i.e. there are several consecutive plots on one side at one or both ends of the line. Other errors include the line being too thick, i.e. over half a small square, discontinuous, or containing a clear bend. Candidates should use a single piece, 30 cm ruler for this examination.

In part (b)(iii) candidates were asked to **determine** the value of λ from the graph. There were several common errors seen. The first mark is for using a **large triangle which covers at least half of the plotted points** to calculate the gradient. Many candidates used the first and last points, or other data points from the table. This is only acceptable if the data points lie **exactly** on the best fit line. Candidates should find places where the best-fit line crosses an intersection of the grid lines near the top and bottom of the best-fit line and **mark these as a triangle on the graph**. Those that drew the triangle on the graph tended to make fewer mistakes and those that used awkward scales were often only successful when sensible values were used. Some candidates included a factor of 100, presumably as they were attempting to convert from cm to m, which led to an incorrect value for λ. The final mark could be awarded from an incorrect gradient, but often candidates used too many or too few significant figures, included a unit (often cm) or gave the value at negative.

In part (b)(iv) candidates had to **determine** a value for the constant A_0. Most scored at least one mark. Many read the value of lnA_0 correctly from the graph and those that used a sensible scale were the most successful. There were some that tried to extrapolate the scale beyond the grid or gave no evidence of where their value for lnA_0 came from, which could not score this or the final mark. Some candidates correctly calculated the value using the calculated gradient and a set of data points lying on the best-fit line. The most common error here was using a point not on the best-fit line which could not score this or the final mark. Many scored the second mark by converting the log value, but some candidates used the incorrect antilog function. Some candidates used the original formula, which was accepted provided the values used were taken from a point lying on the best-fit line. The final mark was for the correct value given to the nearest mm with the unit. The most common errors were giving answers to a tenth of a mm or omitting the unit.

Part (b)(v) involved **explaining** why the value of A_0 may not be accurate. This was not answered well as often candidates gave vague answers. The first mark was for an evaluation of the graph or the method, and the second was for the effect this would have on the best-fit line. Most marks were scored via the first option, however many candidates seemed to think that there was not enough data to plot the graph despite there being at least five data points. Some candidates did describe the scatter in the data but then referred to the graph being uncertain rather than the best-fit line. Some candidates stated that there may be a systematic error in the measurement of amplitude, although they rarely linked this to the effect this might have on the best-fit line. Some candidates did have the idea that there was not enough data near A_0 but often missed the idea that the shape of the graph would be uncertain.

Question 4

This question determining a value for *g* by timing a sphere travelling down a ramp. The analysis of uncertainties is common to all past papers therefore candidates should analyse uncertainties on a regular basis, either whilst making measurements or using past papers. Candidates should read Appendix 10 of the specification and **include all working** as marks are awarded for the method.

In part (a) candidates had to **explain** why it was appropriate to record the uncertainty of the difference in height as 1 mm. The first mark was for identifying the **resolution** of the metre rule. Some candidates did this but either went no further or calculated a percentage uncertainty from a value given later in the question. These candidates clearly misunderstood how uncertainties are combined in this situation. There were very few that used the terms precision or accuracy, neither of which are accepted as an alternative for resolution. Failing to specifically identify the resolution of the metre rule was also the most common error. Although this could be implied from a calculation, there had to be a clear reference to the resolution and 1mm. The second mark was for identifying the uncertainty in the measurement as 0.5mm which most candidates did but occasionally a unit was missing which was not accepted. The final mark was often scored by stating a formula, but this could only be scored if the uncertainty was identified.

In part (b)(i) candidates had to **explain** how moving the second marker further down the ramp would affect the percentage uncertainty in the measurement of time. The most common error was to only discuss *s*, *h*, or no measurement at all. Many candidates fell into this trap and gave effectively perfect answers but not about time. Occasionally, candidates would state that the percentage uncertainty would increase despite noting that the time would increase. The second mark was omitted most as candidates did not discuss the uncertainty in the measurement of time.

Part (c) involved analysing the data to deduce whether the student's value of *g* was accurate. In part (i) they were asked to **determine** the student's value of *g.* It should be noted that a sensible number of significant figures is expected in a practical paper, so the mark may not be awarded if there are too many. It is good practice to give the answer to a derived quantity to the fewest number of significant figures given in the data. Candidates often substituted the values correctly, but the most common error was incorrect powers of 10 in converting units or not converting the units at all. Unit errors were rare for this question. Occasionally, candidates forgot to square the value of *s* which led to an answer that looked valid but was incorrect.

In part (c)(ii) they were asked to **show that** the percentage uncertainty in the value of *g* was about 7%. Candidates used two methods of solving this, either by combining percentage uncertainties or by using the maximum and minimum method. In general, the percentage uncertainty method was understood well and often lead to full marks. Those that did not score full marks usually made an arithmetic error or gave the final value as 7%. Those that used the maximum and minimum method were often less successful as they used maximum/maximum and minimum/minimum, or they made the same error as in part (i). Other errors included not calculating the half range or rounding values too early. Occasionally, candidates added the absolute uncertainties which was not credited as the method is invalid.

Finally, in part (iii) the candidates were asked to **deduce** whether the student's value of *g* was accurate. This is a standard type of question used in every series and was performed well by most candidates, but there were a few that did not attempt this or just made a vague statement with no calculation. It is expected that candidates **use the percentage uncertainty to calculate limits**, but the most common error here was calculating the limits of the quoted value of *g* rather than the calculated value of *g*. Occasionally, candidates calculated the wrong limit, for example the lower limit when the upper limit was needed. Candidates that used the maximum/minimum method in part (ii) sometimes did not state what values they were comparing *g* to in this part, so could not be awarded any marks. The final mark was for a correct conclusion with a comparison. As in previous series, the main error with the conclusion was not explicitly making a comparison between relevant values. The percentage difference method is used less but centres should note that the formula for percentage difference, or percentage error, should include the value being compared to in the denominator not the measured value.

Summary

Candidates 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. They should make measurements on simple objects, using vernier calipers and micrometer screw gauges, and complete all the Core Practical experiments given in the specification.

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

- Be able to describe how to measure lengths, angles, force, mass, time, potential difference, current, pressure and temperature using the most appropriate apparatus and techniques.
- Refer to random or systematic errors when explaining techniques.
- Practice the process of planning an experiment to obtain sufficient and valid data using the formula given.
- Show working in all calculations and include a unit. Check the number of decimal places or significant figures needed for different calculations.
- Choose graph scales that are sensible, i.e. the value of a small square is 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, e.g. 0.25, 3, 4 or 7.
- Plot data using neat crosses (× or +) and check any points that lie far from the best-fit line. Circle any points that are not being used to judge the best-fit line.
- Use a one piece, 30 cm ruler to draw a straight best fit line. Ensure there are data points on both sides of the line, and the line cannot be rotated.
- Draw a large triangle that covers at least half of the plotted data 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 IAL specification.
- Revise the content of WPH13 as this paper builds on the knowledge from AS.

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