Examiners' Report
Principal Examiner Feedback

October 2024

Pearson Edexcel International Advanced Level
In Physics (WPH13) Paper 1
Practical Skills in Physics I

General

The IAL paper WPH13 Practical Skills in Physics I assesses the skills associated with practical work in Physics. 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 3 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 at AS level. These can be found in Unit 3 and Appendix 10 of the specification. In addition, command words may be used which 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 October 2024 covered the same skills as in previous series and was therefore similar in demand.

Question 1

This question was set in the context of determining the viscosity of a liquid. This type of experiment should be familiar as the techniques are similar to those in Core Practical 4: Viscosity.

Part (a) involved determining the diameter of the steel sphere using vernier calipers. The techniques for using vernier calipers can be found in several Core Practicals. In part (i) candidates had to **determine the percentage uncertainty in a single measurement** of the diameter of the sphere. It is expected that the uncertainty in a **single** measurement is **half** the resolution. Some candidates used the full resolution, which was not accepted. Some candidates used resolutions of 1 mm or 0.01 mm despite the diameter being given to **one** decimal place, i.e. the resolution of vernier calipers. Candidates should note that percentage uncertainties should be given to one or two significant figures.

In part (a)(ii) candidates had to **explain** another **technique** for this measurement. Many either described another **method**, such as measuring several identical spheres stacked together, or just stated another instrument, such as a micrometer. Some candidates repeated the information given in the question which does not score any marks. In addition, some referred to using a ratchet which is not a technique for vernier calipers. Those that did identify the correct technique rarely scored the second mark. An **explanation** should refer to the **type of error**, in this case systematic error. Candidates should note the spelling of "systematic" as words such as "system" or "systemic" cannot be accepted. In addition, at A2 level candidates are expected to give more detail, such as check **and** correct for zero error.

In part (a)(iii) candidates had to **describe** a simple method to determine the density of steel. Most candidates produced a good attempt at this. Descriptions of a displacement method to determine volume were not credited. The most common errors were using radius without reference to the diameter or using an incorrect formula for the volume of a sphere.

In part (b) candidates were presented with the apparatus used to determine the viscosity of a liquid. Candidates were asked to **describe** how to ensure that the sphere was travelling at **terminal** velocity between the two rubber bands. Many responses to this question suggested that candidates had not carried out a similar experiment before. Some candidates misunderstood this question as they described how to make terminal velocity happen earlier, by suggesting that the tube must be long enough or the first band far enough away from the start position, rather than how to use measurements to check the sphere was travelling at terminal velocity. Other unnecessary modifications included using thicker more viscous fluids or lower temperatures, making the tube vertical or changing the angle to avoid touching the sides. Some candidates included additional theoretical considerations which were unnecessary for a method, such as a discussion of viscosity, Stoke's law and laminar flow. It appeared that many candidates had missed the term "terminal" as they only described how to measure velocity rather than measuring **two** velocities in **two** places. Although the question referred to measuring time with a stopclock, many candidates added apparatus such as light gates or video cameras which were rarely described adequately enough to score marks. Candidates should also consider how to measure time using a stopclock accurately. Methods that scored well were structured and often included additional rubber bands.

Finally, in part (c) candidates were given a calculated value for the viscosity of the liquid with its percentage uncertainty, and the viscosity of castor oil. They were asked **deduce whether** the liquid could be castor oil. This was generally done well as this is now a familiar type of question. It is expected that candidates **use the percentage uncertainty to calculate limits** although the most common error was calculating the limits of the stated viscosity rather than the calculated viscosity. The final mark was for a correct conclusion including a comparison between relevant values. Candidates appear to be using "compare and conclude" more routinely, but sometimes the comparison was missing.

Question 2

This question was set in the context of investigating the current-potential difference characteristics of components inside a sealed box. This bears some resemblance to Core Practical 2: Electrical Resistivity and Core Practical 3: EMF and Internal Resistance.

Part (a) concerned designing an appropriate circuit for the investigation. In part (i) candidates had to complete the circuit diagram. Responses to this part suggested that candidates lacked experience in drawing and using circuit diagrams for I-V characteristics investigations. Many candidates did not include a power supply of any description and more did not include a variable resistor to vary the current in the circuit. It is expected that standard symbols are used so boxes with a label are not accepted for standard components. In addition, some candidates drew a thermistor symbol rather than a variable resistor, and some included additional, unnecessary components such as filament bulbs. Most candidates were able to place an ammeter and voltmeter in the correct position, but the most common error was placing the voltmeter across the fixed resistor instead of the sealed box.

In part (ii) candidates had to **explain** why the fixed resistor was needed in the circuit. This type of question is fairly common so most candidates stated the reason for including a fixed resistor, i.e. to limit the current or prevent a short circuit. Some candidates referred to “controlling” the current, which was too vague and could only be credited if it was related to the maximum current. Very few went on to explain what would cause this to happen because of a diode being present in the circuit. For those that did, most did refer to the diode’s characteristics but only a few discussed the direction of potential difference.

In part (iii) candidates and to **deduce which** of the resistors should be used given appropriate data. This type of question appears in other units and candidates should practise structuring their calculations in a logical manner. Many candidates applied a power formula to each of the resistors so could only score one mark. Applying Ohm’s law was credited most often, however some candidates did not use the correct potential difference and used either 0.7 V or 6.0 V. In general, those that applied both formulae correctly scored well, however there were errors in the conclusion. Most of these candidates chose resistor C as they did not recognise that the power rating of the resistor had to be larger than the power dissipated in the circuit. Some did identify the correct resistor, but did not compare their values in their conclusion. Other errors included stating two resistors or using a resistor with a lower resistance than that calculated.

In part (b) candidates were given the results of the investigation in the form of a graph. They then had to **explain** whether the components were arranged in series or parallel. Many candidates did not appear to understand how a diode works. Some candidates stated series or parallel with no explanation, so could not score any marks. The most common misconception was stating that the combination was in series as the potential difference was shared. Some did refer to the components being in parallel, but did not refer specifically to regions of the graph so could not score marks. Occasionally, candidates referred to the potential difference decreasing which was too vague. The best answers referred to the combination acting as a fixed resistor for negative potential differences. A few candidates referred to the region of positive potential difference, but this had to be explained in terms of the resistance of the diode to score the mark.

Question 3

This question was based on an experiment to determine the refractive index of a liquid. Although this was an unfamiliar context, the techniques for measuring distances are found in many Core Practicals.

In part (a) candidates had to **describe** an **accurate** method to determine a **single value** of the distance using a metre rule. As this was a **single** value, repeating and calculating the mean was not accepted. In general, this was answered well. The first mark was for **describing how to place the metre rule**. Some candidates did not use terminology correctly. For example, “straight” is not a suitable alternative for “vertical”. Both perpendicular and parallel need to be relative **to** something, e.g. perpendicular to the floor. Occasionally, candidates understood that the metre rule had to be vertical but did not include a means of checking it. The second mark was for **describing where the metre rule should be placed**. Candidates often realised that the metre rule should be close, but sometimes they specified close to the stand which was not specific enough as it may be on the opposite side to the beaker. The final mark for **a technique** in using the metre rule was awarded most often. Occasionally, it was unclear whether a set square was being used to ensure the metre rule was vertical or for reading off measurements. It is also recommended that candidates avoid the use of "horizontal" and "parallel" when describing taking measurements from a scale.

In part (b) candidates had to **criticise** the recording of the data. This is a familiar type of question from previous series, so candidates did this well. Most candidates realised that the readings for both variables had inconsistent decimal places. Similarly, candidates also realised that there was not enough data to draw a reliable graph, although occasionally the wording appeared to merge this with repeating to determine a mean. A few candidates stated that a value did not fit the pattern, but they did not state specifically which point they were referring to. As is usual, candidates often referred to intervals of data which is not credited.

Part (c) involved **calculating** a mean and percentage uncertainty from a set of data. Most candidates scored marks. It is **not** expected that candidates identify and remove an "anomalous" data point from these calculations, but those that did were given some credit. In part (i) the first mark was for a calculation of the mean, which most managed. The final mark was for the correct value of the mean given to the **same number of decimal places as the data**. Many candidates gave too many decimal places and occasionally candidates included a unit which was not needed.

In part (ii) the candidates **must show** the calculation for the first mark, and this is awarded for calculating the **half range or furthest from the mean**. Using the full range is not given any credit. Occasionally, candidates gave what appeared to be a resolution, or calculated the half range but did not convert to a percentage. The final mark was for the correct percentage uncertainty. Candidates should note that percentage uncertainties should be given to one or two significant figures.

Question 4

This question included plotting and analysing the graph for determining the mass of a metre rule using moments. A question involving a graph appears in each series and the mark scheme follows a common format. Therefore, there is plenty of opportunity to practise this skill and consult Examiner's Reports to correct common errors.

The candidates were given the relationship between the two distances, *K* and *L*, shown on the diagram. In part (a) they were asked to **explain** how a graph of *K* against *L* could be used to determine the value of the mass of the metre rule M_R. This was more difficult than similar questions in previous series as this related to the *y* intercept instead of the usual gradient. As the formula needed no manipulation, the first mark was for relating the formula to $y = mx + c$ **and** stating that the *y* intercept was equal to $\frac{0.2M_R}{M_A}$. Some candidates wrote the comparison beneath the formula, which was given credit, but some that used arrows missed out the + and = which is not credited. Some stated that $c = \frac{0.2M_R}{M_A}$ but they needed to define *c* in relation to a graph to achieve full marks. As this is an "explain" question, candidates are expected to explicitly state what *c* (or *m*) refer to as loops and arrows are not accepted. The final mark was for describing how to calculate M_R using the *y* intercept, although some did not manipulate this correctly, or simply stated that M_R is the *y* intercept.

Part (b) assessed the candidates' ability to plot the graph of *K* against *L* and use the graph to determine the mass of the metre rule M_R. Part (i) was plotting the graph. This scored better than in previous series as graph plotting appears to have improved. The first mark was for **placing the axes the correct way around and labelling with the correct quantity and a unit**. As the labels were given in the table, errors were rare however occasionally candidates would miss out the units or use the incorrect format, i.e. quantity (unit) rather than quantity / unit.

The second mark was for **choosing an appropriate scale**. At this level, the candidates should be able to choose the most suitable scale so that the small squares are 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. In most cases a landscape graph unnecessary. Candidates 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. In addition, axes can start at zero provided the plots cover over half the page. **Scales based on 3, 4 (including 0.25) or 7 are awkward and not accepted** as these often lead to errors in plotting and data extraction. Candidates should label every major axis line, i.e. every 10 small squares, with appropriate numbers so that examiners can easily see the scale used. Occasionally, candidates shifted their axes so that the labels were inappropriate numbers which can also lead to errors.

There are two marks 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. Mis-plots were uncommon, but candidates should check a plot if it lies far from the best fit line.

The final mark is for a **reasonable best-fit line** and this mark was awarded often. A reasonable best-fit line should have plots either side of the line and cannot be rotated. Candidates should also circle a data point that is not being used to judge where the best-fit line should be. Where candidates were not awarded this mark it was either because the line was too thick, i.e. over half a small square, discontinuous, or had a clear bend. Candidates should be encouraged to use a one piece, 30 cm ruler for this examination. For those candidates whose graph produced a clear curve, this was awarded for a reasonable attempt at a curve.

In part (ii) candidates were asked to **determine the gradient of the graph**. There were several common errors seen. The first mark is for using a **large triangle that covers at least half of the plotted points** to calculate the gradient of the graph. 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 **to mark these as a triangle on the graph**. Those that drew the triangle were less likely to make mistakes, and those that used awkward scales were often only successful when sensible values were used. Some candidates also stated dx/dy which was not credited. The final mark could be awarded from an incorrect calculation, but often candidates used too many or too few significant figures.

Part (iii) was for **determining a value for the mass M_B**. Some candidates tried to use the formula to calculate this rather than the gradient. Most candidates calculated a correct value from their gradient, but some did not give their answer to the nearest gram or include a unit.

In part (iv) candidates were asked to **determine the value of M_R**. Those that used the y intercept were the most successful, although those that did not start their x axis from zero mistakenly used this value. Other errors arose from misreading the scale, usually when the scale was given in 0.25, or from mislabelling the scale on the y axis. Some candidates used their calculated gradient and a data point from the best-fit line. Some common errors were incorrectly rearranging the formula or using a point from the table that did not lie on the best-fit line. In some cases, values for the y intercept appeared with no evidence of the line being extrapolated or being calculated, therefore could not be awarded some of the marks. The final mark was for their calculated answer to the nearest gram with a unit, but often this was given to the nearest 10 grams.

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 the performance on this paper.

- Learn what is expected from different command words, in particular the difference between describe and explain.
- Be able to describe how to measure lengths, angles, force, time, potential difference and current using appropriate apparatus and techniques.
- Refer to random or systematic errors when explaining techniques.
- Practise writing experimental methods including identifying safety issues specific to that experiment.
- Show working in all calculations and give answers using appropriate significant figures and a unit.
- Choose graph scales that are sensible, i.e. the value of the smallest 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.
- Use a one piece, 30 cm ruler to draw straight best-fit lines. 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 at AS level. These are given in Unit 3 and Appendix 10 of the IAL specification.