Examiners' Report
Principal Examiner Feedback

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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 for 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.

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)

This question asked students to outline a method, including named equipment, to vary the temperature of the thermistor up to 100˚C and down to 0˚C. Any unsafe methods described were ignored.

She heated the thermistor to 100 °C and measured the potential difference V across it. She decreased the temperature θ and recorded further measurements of V and θ until the temperature reached 10 °C.

(a) Describe how the student was able to vary the temperature θ of the thermistor for this investigation.

(2)

By using a waterbath with hot water or

~~By~~ by using an ice bath to cool It

Question 1 (b)

This question asks students to perform a standard calculation of percentage uncertainty for a single reading. This is listed as a skill required at WPH13 (section 3.5 of the specification) and the method is outlined in Appendix 10 of the specification.

This example shows a correct calculation for 2 marks.

Calculate the percentage uncertainty in the value of V shown.

(2)

Resolution = 0.01 $\frac{0.01}{2} = \pm 0.005$ $\frac{0.005}{6.85} \times 100 = 0.073\%$

Percentage uncertainty = $\pm 0.073\%$

However, most students did not equate the uncertainty in the value to half the resolution. If the whole resolution was equated to uncertainty, then the percentage uncertainty was calculated, we awarded 1 mark.

Calculate the percentage uncertainty in the value of V shown.

(2)

percentage uncertainty = $\frac{0.01}{6.85} \times 100\ \% = 0.15\ \%$

Percentage uncertainty = 0.15 %

Although the question did not instruct them to draw a line of best fit, most students correctly realised that this was required to estimate the *y*-axis intercept value.

As the plots provided were close to linear for the lower temperatures, we accepted either a straight or curved line of best fit. A tolerance was allowed in the value of *V*. However, the value did need to be supported by the line of best fit, as some students gave a value that was contradicted by their line of best fit.

(i) Estimate the value of V for a temperature of 0 °C.

(2)

8.4 V

(ii) Calculate the resistance of the thermistor at a temperature of 0 °C.

(3)

$V = IR$

$12 = I \times 4700$

$I = 1175/3$ A

$V = IR$

$R = \frac{V}{I}$

$R = \frac{8.4}{1175/3}$

Resistance = $21.4 \times 10^{-3}\ \Omega$ ~~0.02 Ω~~

In the example below we can see that 12 V has been used with the 4.7 kΩ resistance to calculate the current in the circuit.

So, this example only scored 1 mark for (c)(ii).

Where in this example, the student has corrected their answer and scores full marks for (c)(ii)

The replacement calculation correctly uses 3.6 V as the pd across the 4.7 kΩ resistor, leading to a correct current value. This is they used with the pd across the thermistor (8.4 V) to calculate the thermistor resistance.

(i) Estimate the value of V for a temperature of 0 °C.

(2)

8.4 V

(ii) Calculate the resistance of the thermistor at a temperature of 0 °C.

(3)

At 0 °C, with $V = 8.4\text{V}$ $\therefore R = \frac{V}{I}$

$\cancel{\left(I = \frac{V}{R} = \frac{12}{4.7\times10^{3}}\right)}$ $= \cancel{\left(\frac{8.4}{V \div (4.7\times10^{3})}\right)}$ $R = \frac{8.4}{7.6596\times10^{-4}}$

$I = \frac{3.6}{4.7\times10^{3}} = 7.65957\times10^{-4}\,\text{A}$ $\simeq \cancel{3690\,\Omega}$ $= 10{,}966\,\Omega$

$\simeq 11{,}000\,\Omega$

Resistance = ~~6290 Ω~~ 11,000 Ω

Question 1 (d)

This question highlighted the issues that still arise with interpreting the command words used in questions. The command word determine is defined in the specification as “the answer must have an element which is quantitative”.

So, to answer this question some calculation was required to give evidence for their decision whether potential difference V was inversely proportional to temperature θ in Kelvin.

The first issue that arose was that many students did not even consider the temperature in Kelvin.

The second issue was the basic definition of inversely proportional.
(eg $y = \frac{constant}{x}$ or $y \times x = constant$)

Determine whether she is correct.

(2)

As temperature increases, the resistance of the thermistor decreases, the voltage across thermistor decreases.

For 1st set at 0°C = 273K. For 2nd set at 10°C = 283K.

8.6 × (0+273) = 2348   7.5(10+273) = 2122.5 = 2123V.

For 3rd set, 5.7 × (30+273)

= 1727.1.   ∴ 2348, 2123 and 1727 are different,

(Total for Question 1 = 11 marks)

the student is wrong, and also she has to measure pd for negative temperatures then she can fully answer

Here we can see the use of +273 to convert θ in ˚C into K and the multiplying of V and θ, ultimately showing that this did not result in a constant (so they are not inversely proportional).

Without any calculations shown, students scored 0.

Question 2 (a)

This question proved a challenge. Students who understood WPH12 core practical 4 (speed of sound) and understood the effect of varying the path difference on constructive and destructive interference generally did well on question 2.

Many students focused on the intensity of light (microwaves in this case) being an inverse square relationship, so moving the plates changed the intensity. However, we did not accept this explanation as the metal plate distance was fixed.

(a) As d varied, the intensity of the microwaves detected by the receiver varied.

Explain why.

(3)

As the reflection of wave from glass plate and metal plate meets up, there is wave interference. If the path difference of the two waves meet up is ~~a~~ constructive interference, the intensity increases. If the the two waves meet up in destructive ~~ff~~ interference, the intensity decreases. When the metal plate is moved, the path difference changes, hence the type of interference also changes. Resulting intensity varies when detected by the reciever.

Question 2 (b)

Students who had understood WPH12 core practical 4 (speed of sound) knew that the positions of the maxima were where the two reflected waves were in phase – so the path difference was nλ. So, students needed to subtract pairs of values to calculate the distance moved by the plate.

The best answers realised that the path difference was 2×d (as the wave travelled from the glass plate to the metal plate and back again).

Although many found (b)(i) difficult, many students then correctly calculated a frequency for their value of wavelength, so performed well on (b)(ii).

(b) The student recorded values of *d* when the receiver showed a maximum value of intensity.

He recorded *d* for a sequence of five maxima.

Maxima	1	2	3	4	5
d / cm	9.9	11.1	12.7	13.9	15.4

1.2 1.6 1.2 1.5

(i) Determine the wavelength of the microwaves being transmitted.

(3)

$(1.2 + 1.6 + 1.2 + 1.5)/4 = 1.38\,cm$

$= 0.0138\,m$

$= 0.014\,m$

$\frac{\lambda}{2} = L$

$\lambda = 0.028\,m$

Wavelength = 0.028 m

(ii) Calculate the frequency of the microwaves being transmitted.

(2)

~~$v = f\lambda$~~

~~$f = \frac{3\times10^8}{0.0138}$~~

~~$= 2.17\times10^{10}\,Hz$~~

$v = f\lambda$

$f = \frac{3\times10^8}{0.028}$

$= 1.07\times10^{10}\,Hz$

Frequency = ~~$2.17\times10^{10}\,Hz$~~ $1.07\times10^{10}\,Hz$

In this example, you can see the student has corrected themselves.

Initially, they treated this as core practical 4, taking the difference in position as the wavelength. This mistake was initially followed through to (b)(ii).

Fortunately, they realised the mistake and corrected it in both parts, scoring full marks for both parts.

Question 3 (a)

Students who had an experience of either WPH11 core practical 3 (Young's modulus) or the Hooke's law experiment performed well here. Below is a good example.

3 A student was asked to investigate the ultimate tensile stress of a sample of thin nylon fishing line.

(a) Describe a method to determine the maximum force the nylon fishing line can withstand before breaking.

(4)

The student should take a nylon thread and measure its diameter using a vernier calliper and the length using a meter rule. Take one end of the nylon ~~th~~ line and attach it to a clamp. Take the other end and ~~att~~ put it around a pulley and use it to hang known masses (Measure it using a pan balance) Keep adding the measured masses in small amounts until the Nylon line snaps / breaks. Note the maximum mass it can withstand and use F=mg to find the force. Use stress = F/A to calculate the tensile force.

However, many students described methods to determine breaking stress from a graph, then calculating maximum (breaking) force. In some cases, such students could still be awarded some of the marks available.

In the example below, with no explanation of how the force mentioned in the stress calculation is determined (eg use of slotted masses), or how the experiment is set up (eg nylon hung from a clamp), this example scored 0 marks as it answers a question for a different practical scenario.

3 A student was asked to investigate the ultimate tensile stress of a sample of thin nylon fishing line.

(a) Describe a method to determine the maximum force the nylon fishing line can withstand before breaking.

(4)

Set up an apparatus to measure the extension and force acting on the nylon fishing line when slotted masses are added. Measure the area and initial length of the nylon line. Calculate Stress (F/A) and strain ($\Delta x/x$), and plot a graph of stress on the y-axis and strain on the x-axis. The largest value of stress on the graph is the Ultimate tensile stress, by ~~dividing~~ multiplying ~~this~~ value by the area of the nylon line the maximum force the nylon fishing wire can withstand can be found.

Question 3 (b)

This question tested students understanding of the safety issues.

As most students will have performed similar experiments (during WPH11 studies or while studying for earlier qualifications), most gave answers with sufficient detail to outline the issue and the equipment/safety considerations that would alleviate the issue.

(b) Identify one safety issue with this investigation and how it may be dealt with.

(2)

When the fishing line breaks it may snap and hurt people's eyes. So protective eyewear should be worn.

Question 3 (c)(i)

This question asks students to perform a standard calculation of percentage uncertainty for repeated readings.

This is listed as a skill required at WPH13 (section 3.5 of the specification) and the method is outlined in Appendix 10 of the specification.

Most correctly calculated the mean diameter value and correctly used half the range of the repeated values as the uncertainty.

Some incorrectly omitted values as anomalies, so were not awarded the full marks. However, these students could still be awarded the mark for using half the range to calculate a percentage uncertainty.

Overall, students performed well.

(c) Before testing, the student measured the diameter at five points along the sample of nylon fishing line.

0.55 mm   0.57 mm   0.54 mm   0.55 mm   0.53 mm

(i) Calculate the percentage uncertainty in the mean diameter of the nylon fishing line.

(3)

$$\text{Mean} = \frac{0.55 + 0.57 + 0.54 + 0.55 + 0.53}{5} = 0.548$$

$$\text{range} = 0.57 - 0.53 = 0.04 \therefore \%\,\text{uncertainty} = \frac{\frac{\text{range}}{2}}{\text{mean}} \times 100$$

$$= \frac{0.02}{0.548} \times 100$$

$$= 3.65\,\% = 3.7\%$$

Percentage uncertainty = 3.7 %

In the example above we can see a correct mean and the use of half the range.

We ignored the “double rounding” error at the end as the correct answer (3.649%) was often rounded up to 3.65% rather than correctly rounded down to 3.6% as the data was given rounded to 2 significant figures.

Question 3 (c)(ii)

The best students understood that to evaluate, they needed to "review information then bring it together to form a conclusion, drawing on … relevant data" and that they needed to "come to a supported judgement".

As the statement they were asked to evaluate was a decrease in tensile stress of 10%, students were expected to calculate stress using the data provided and compare this to a 10% decrease, before making a final judgement.

As the judgement needed to be supported by the students work, it was possible to score high marks even with minor errors in the calculations (eg answers incorrectly using diameter instead of radius to calculate the cross-sectional area could still achieve 4 marks)

In this example, we can see both stress calculations and a calculation of the percentage decrease. This percentage decrease is then compared to the 10% quoted and a conclusion is made based on this comparison. So, this example scored full marks.

Evaluate whether her results support the suggestion in the article.

(5)

Before: $UTS = \frac{F}{A} = \frac{65.8}{1.6 \times 10^{-7}} = 4.11 \times 10^{8}\ Pa$ $\left\{ A = \frac{\pi (D)^2}{4} = \frac{\pi \left(\frac{0.45}{1000}\right)^2}{4} = 1.6 \times 10^{-7}\ m^2 \right.$

After: $UTS = \frac{F}{A}$

$A = \frac{\pi (4.6 \times 10^{-4})^2}{4} = 1.66 \times 10^{-7}\ m^2$

$UTS = \frac{57.8}{1.66 \times 10^{-7}} = 3.5 \times 10^{8}\ Pa$

$\frac{3.5 \times 10^{8}}{4.11 \times 10^{8}} \times 100 = 85.2\%$

$100 - 85.2 = \cancel{15}\ 14.8\% \approx 15\%$

$15\% > 10\%$ ~~so~~ ~~less~~ ~~her~~ ~~the results~~ do

So her results ~~doe~~ do not support the articles suggestion.

Question 4 (a)(i)

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 decimal places” is not clear enough, as this is only related to values of *r*.

Note, we did accept significant figures here, but measurements should have consistent decimal places (eg matching the measuring device), while calculations should have consistent significant figures (eg linked to the data used in the calculation)

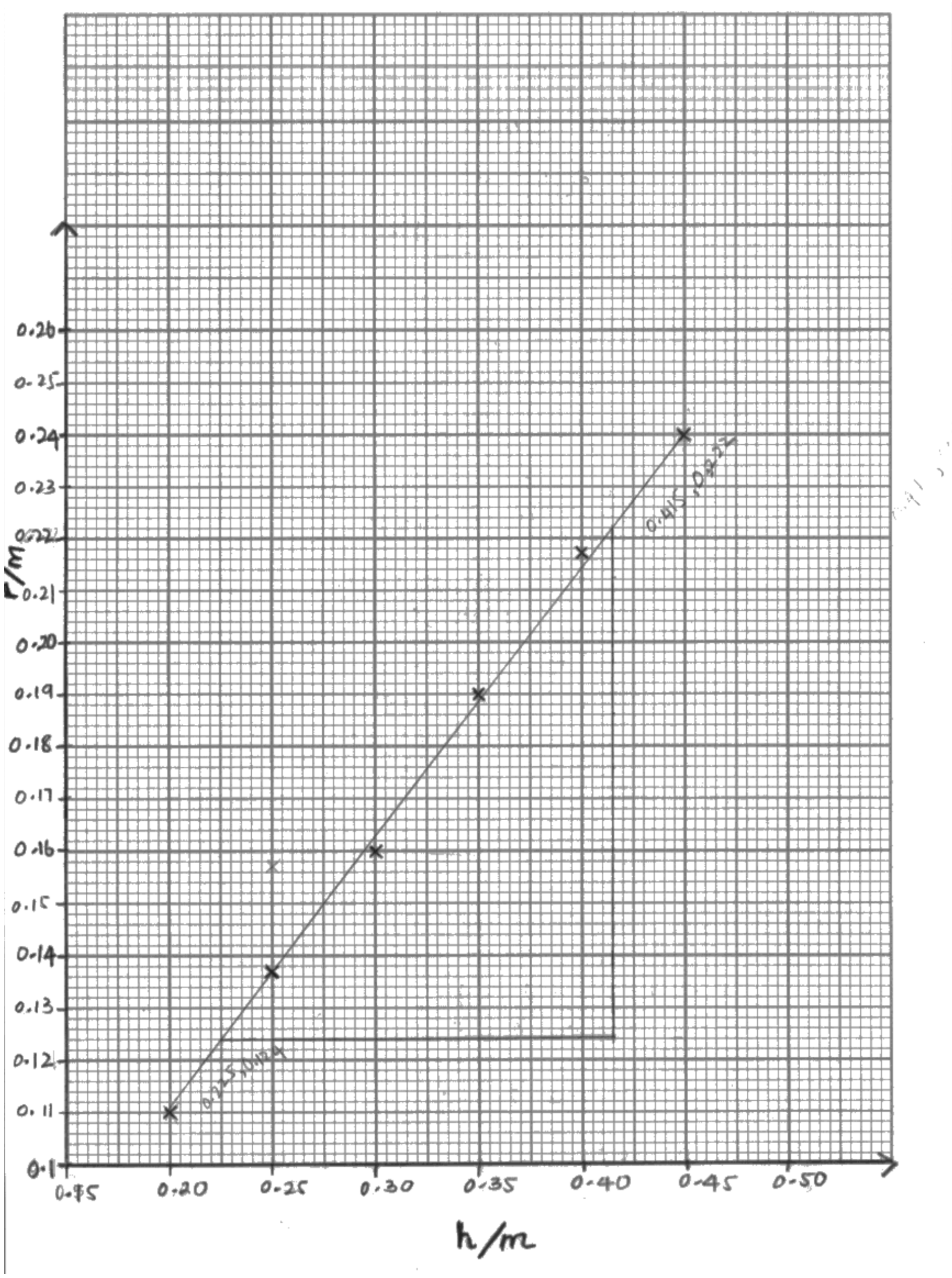
A small number of students gave lists of irrelevant answers, that seem to be memorised answers to previous papers. These were ignored as irrelevant.

Question 4 (a)(ii)

Plotting of graphs using provided or calculated data is a common requirement of WPH13 (and WPH03 previously)

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

- Missing/incorrect units for axis labels – axes need complete labels, with units given **using a forward slash symbol**, eg *r* / m.
- 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 *x* and *y*-axis scales starting a 0, which meant the graph often had an unsuitable scale for at least 1 axis.
  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.
  It is still common to see large dots (almost the size of a 2 mm square) as plots
  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).



- both axes correctly labelled.
- *y*-axis scale of 0.02 and *x*-axis scale of 0.05 every 2 cm, with plots covering over half of the space on each axis.
- all plots were checked within 1 mm.
- a good, well-balanced attempt at a line of best fit.

As such, this example scored all 5 marks.

Question 4 (b)(i)

Most students incorrectly attempted to use the equations of motion (suvat) to answer this question. However, very few were successful as *h*, *r* and acceleration g were vertical vectors, but u and v acted along the ramp.

The students who correctly identified this as an example of conservation of energy (change in gravitational potential energy store = change in kinetic energy store) usually scored full marks. As this question asked them to "show that…" they were expected to show all the steps in their working.

Question 4 (b)(ii)

Having provided the equation in 4(b)(i) for the relationship between *u* and *h*, students were expected to realise that *v* and *r* were linked in the same way. This step proved difficult for many students.

Once this was realised, students could then derive an expression for e in terms of *r* and *h*, the only quantities recorded and used for the graph, eg $e = \frac{\sqrt{r}}{\sqrt{h}}$ or $r = e^2 \times h$

The final step required was to equate this expression to $gradient = \frac{\Delta r}{\Delta h}$ or $y = mx + c$

Question 4 (c)

In 4(b)(ii) students were told that e^2 is equivalent to the gradient of the graph. So, students were expected to determine the gradient of their graph.

Most did this successfully. However, many students forgot to square root that value so chose the wrong metal.

Question 4 (d)

The value students obtained for e came from a graph of *r* and *h* values. As such, their explanation for this question needed to focus on the effect of friction on the *r* values (as h would be unaffected) and how that would affect the *e* value determined.

Most students only discussed the effects on the two speeds *u* and *v*, so could not be awarded marks as the second mark was dependent on the first being awarded.