Examiners' Report
June 2015

GCE Physics WPH06 01

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Introduction

The paper WPH06 assesses the skills associated with practical work in Physics and addresses the skills of planning, data analysis and evaluation. Set in a wide variety of contexts the questions will be more accessible to those candidates who have, themselves, carried out a range of practicals in the laboratory and who can formulate a plan, which at this level will consist of several stages. There are questions concerning choice of apparatus, and the use of that apparatus, that will be immediately familiar to those with the experience of using such apparatus. The title of the paper, Experimental Physics, is the same as that for unit 6PH06 for UK centres and the mark scheme for each paper is designed to reflect the demands made on UK candidates in their coursework. In this way all candidates face the same test at A2.

The style of the paper is that there are four questions that combine to test the range of practical skills from the beginning of the experiment to the end. The first question will usually address the selection and use of measuring instruments. The middle two questions will ask the candidate to plan an experiment and analyse some data from another; the plan is usually one mentioned in the specification but the analysis could be from an unfamiliar context. The final question asks the candidate to consider a practical situation that they might have seen in the laboratory and to answer questions on how such a practical might be carried out; there will normally be some data to analyse by drawing a graph. Uncertainty in measurement and its effect on a conclusion are ideas that run through the paper and can occur in a variety of ways; numerical work is expected to show an awareness of the role of significant figures and physical units and candidates are expected to be familiar with standard practice in an A level physics laboratory. The specification contains examples of the subjects and techniques likely to feature in future papers and the best preparation is to carry out those experiments in the laboratory, even if only by demonstration.

Question 1 (a) (i)

This was intended to be a straightforward question at the start of the paper to serve as an easy introduction and very many candidates scored the mark.

(i) She measured the external height of the can using a metre rule.

State the precision of a metre rule.

(1)

± 1mm

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Examiner Comments

We accepted the value of 1 mm in any correct format so, for example, 0.1 cm was marked correct.

Most errors were probably caused by writing errors although some candidates incorrectly thought that 1 cm was the right answer.

ResultsPlus

Examiner Tip

Precision of instruments is something that must be learned and using the instruments themselves is the easiest way to do this.

Question 1 (a) (ii)

This question asked about a technique to measure the diameter of a cylinder using two set squares and a metre rule. There was evidence that candidates knew what a set square was but were generally unfamiliar with its use. Few candidates scored both marks but many scored one for coming up with a way of using two set squares in a sensible manner. It is vital that candidates can draw good clear diagrams that are large and have straight lines drawn using a ruler, here both marks were available from the diagram alone. We looked to see if candidates had added to the diagram at the top of the page but in practice almost none did so.

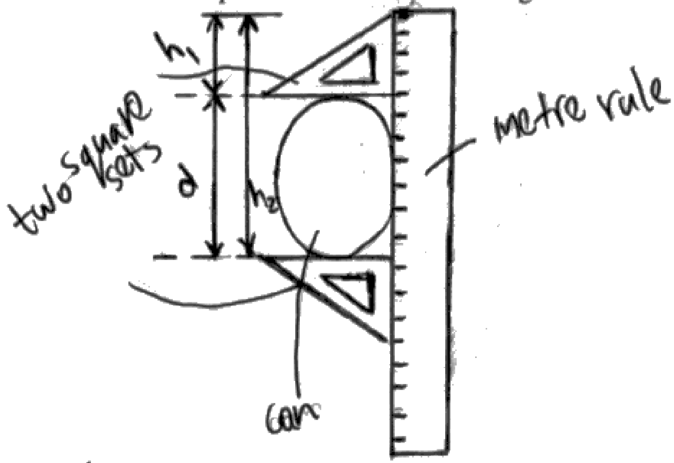
Any correct technique must leave nothing to chance or to the judgement of the measurer. Diagrams are much more convincing in 2 dimensions, as attempts to show three dimensions in a drawing usually lead to confusion. In this question the drawing can be a plan view or an elevation and in some cases it was not clear which was being shown, but this usually did not lose marks. In simple terms, if the drawing shows two triangles (set squares), a circle (end view of can) and a rectangle (rule) the candidate is probably showing enough to convince the examiner. All diagrams should always be labelled.

This candidate shows the best of the answers and there were a good number who came up with this.

(ii) She used two set squares and a metre rule to measure the external diameter of the can.

Describe how you would use this apparatus to measure accurately the diameter of a can. Your description should include a diagram.

(2)



• Use the metre rule and square sets as shown on the diagram

• Measure both h_1 and h_2

• the diameter of the can is $d = h_2 - h_1$

ResultsPlus
Examiner Comments

The set squares are lined up along the metre rule and touching the edge of the can. The candidate has used a metre rule in the past and knows that the numbers start at one end so shows two distances to measured. These two measurements are subtracted to determine a value for the diameter, this is all clearly shown on the large diagram.

It is not clear whether this is a plan view or an elevation but that is unimportant as it is the fundamental measuring technique that is the subject of the question.

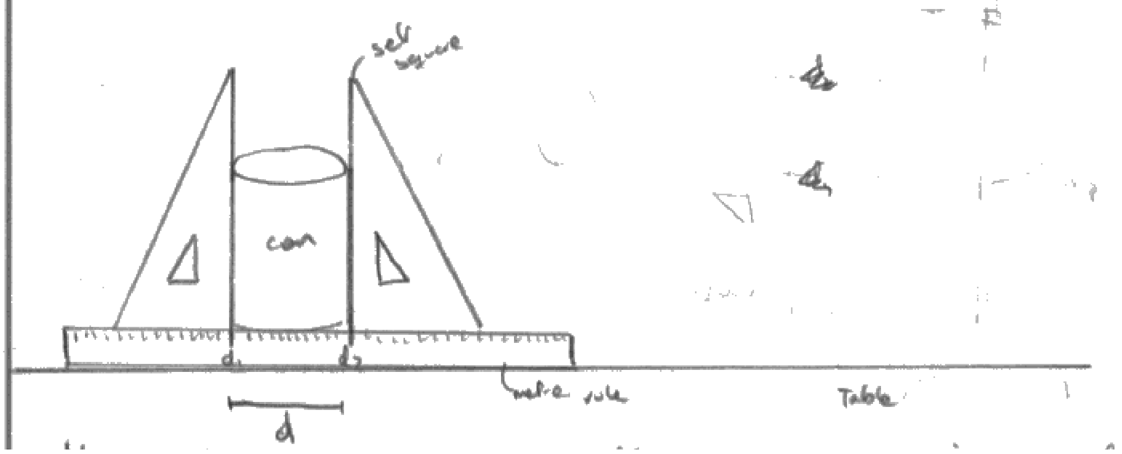
ResultsPlus
Examiner Tip

The difference technique shown here occurs in a variety of situations and is an important one to understand.

A common error was to draw the can in line alongside the set squares. This was where two dimensions was a disadvantage but since the technique is a poor one it would not have scored the second mark.

Describe how you would use this apparatus to measure accurately the diameter of a can. Your description should include a diagram.

(2)



ResultsPlus
Examiner Comments

This is almost certainly an elevation view and it is not certain that the set squares are in line across the widest part of the can, indeed the measurer cannot be sure that they are either. It is not necessarily the true value so scores the mark for use of two set squares but not the second.

ResultsPlus
Examiner Tip

Both the drawings shown for this question are large, clearly drawn using a ruler and have dimension lines. This is good practice.

Question 1 (b) (c)

These questions were generally done well and show that most candidates have a reasonably firm idea about uncertainties in measurements and their use in drawing conclusions. There was some confusion about the use of significant figures (SF) and precision. Apart from the mass the measurements are to 3 SF, so the value for the external volume is 411 cm^3, correct to 3 SF, and since the internal volume is correct to 3 SF when these two are subtracted for the answer to b(ii) we get 15 cm^3 and only 2 SF are justified here. Consequently the calculation for the density should be quoted to 2 SF only. A great number of candidates lost this mark for correct use of SF. The percentage uncertainties were done well but few candidates understood that by subtracting two numbers that are close together we arrive at a value that has a large uncertainty. This is because the actual uncertainties add and we are dividing by a small number, this means the answer is a large number.

This candidate can do the calculations but does not show the processing skills expected at this level.

(c) (i) Use the measurements to estimate the percentage uncertainty in the external volume. You should assume the uncertainty in the height measurement is negligible.

(2)

~~V = πr² 2h~~ V = πr²h

~~v = 9.9% ...~~ v = 9.9%

Percentage uncertainty = ~~99~~ ± 9.9 %

(ii) Use the measurements to estimate the percentage uncertainty in the internal volume.

(1)

~~[crossed out]~~ ~~[crossed out]~~

9.9% + 0.28 = 10.2%

Percentage uncertainty = ~~±10.8~~ ± 10.2% %

(iii) The volume of metal was determined by subtracting the internal volume of the can from the external volume. This produces a percentage uncertainty for the volume of metal which is greater than 10%.

Suggest why.

(1)

Because you add up the percentage uncertainty of the external volume to its % uncertainty

(Total for Question 1 = 11 marks)

ResultsPlus

Examiner Comments

Their value for the external volume is correct but 4 SF is not justified. They score the mark for (i). They also appreciate what they must do to find the volume of the metal and although only 2 SF is justified they score this mark but lose one mark in (iii) because this is where the SF penalty is applied. In this way SF penalties are not applied to every answer or candidates would lose many marks for the same mistake.

The candidate makes a mistake in converting cm^3 to m^3 as can be seen at the bottom and so loses the first mark as well.

ResultsPlus

Examiner Tip

The number of significant figures for a value is justified by the number of significant figures quoted in the measurements.

Take care when converting units and write out the calculation in full.

Candidates need not write that 411 is roughly equal to 400, the examiners are not looking for this explicitly.

(iii) The volume of metal was determined by subtracting the internal volume of the can from the external volume. This produces a percentage uncertainty for the volume of metal which is greater than 10%.

Suggest why.

(1)

The volume of the metal is very small compared to external and internal volumes, therefore % uncertainty will be greater.

(Total for Question 1 = 11 marks)

ResultsPlus

Examiner Comments

This candidate expresses the idea of c(iii) very clearly.

This candidate gives good and clear answers to every part of these questions.

(b) The student recorded the following results.

Quantity	Measurements	Mean value
Internal volume / cm^3	391 399 398	396
Height / cm	10.1 10.1 10.1	10.1
External diameter / cm	7.2 7.1 7.3	7.2
Mass / kg	4.982×10^{-2}	

The volume of a cylinder is given by $V = \pi r^2 h$

where r is the radius of the cylinder and h is its height.

(i) Use these measurements to show that the external volume is about 400 cm^3.

(1)

External volume $= \pi \left(\frac{d}{2}\right)^2 h$

$= \pi \left(\frac{7.2}{2}\right)^2 \times 10.1 = 411\ cm^3$

$\approx 400\ cm^3$ (shown)

(ii) Hence calculate a value for the volume of the metal.

(1)

volume of metal = External volume − Internal volume

$= 411 - 396$

$= 15\ cm^3$

Volume of metal = $15\ cm^3$

(iii) Hence calculate a value for the density of the metal.

(2)

$\rho = \frac{m}{V} = \frac{4.982 \times 10^{-2} \times 10^3}{15}$

$= 3.3\ gcm^{-3}$

Density of metal = $3.3\ gcm^{-3}$

(c) (i) Use the measurements to estimate the percentage uncertainty in the external volume. You should assume the uncertainty in the height measurement is negligible.

(2)

%U in volume = 2 × (%U in d)

$= 2 \times \left(\frac{0.1}{7.2} \times 100\% \right)$

= 2.8 %

Percentage uncertainty = 2.8 %

(ii) Use the measurements to estimate the percentage uncertainty in the internal volume.

(1)

% Uncertainity in internal volume $= \dfrac{\frac{399 - 391}{2}}{396} \times 100\%$

= 1.0 %

Percentage uncertainty = 1.0 %

(iii) The volume of metal was determined by subtracting the internal volume of the can from the external volume. This produces a percentage uncertainty for the volume of metal which is greater than 10%.

Suggest why.

(1)

Since the two values are substracted, %U is not added. Rather, limit of uncertainity of internal and external volume is added to give the total uncertainity of volume of metal, which is large compared to volume of metal. So, %U is more than 10%

(Total for Question 1 = 11 marks)

ResultsPlus

Examiner Comments

In part (b) the candidate uses significant figures as appropriate. Their unit for density is appropriate thus they avoid having to change units and so reduce the chance for error.

In part (c) they clearly show what they are doing with the uncertainties - doubling the uncertainty in *d* because the diameter is squared in calculating the volume. They use the full range to calculate the uncertainty in the internal volume, a candidate who used 4 as half the range would also get the mark but other figures, such as 3 or 5, lost this mark in (ii). They say enough in (iii) to score the mark.

Question 2 (a)

This question deals with choosing the right graph which is a common feature of practical work. At this level the relationship between the variables will always be a non-linear one.

This candidate tries to say things too many times in part (i) and gets in a muddle in part (ii).

(a) (i) Describe how he could make his readings for the time period as accurate as possible.

(2)

Measure the time taken to complete 10 oscillations with each mass. Divide the value obtained by 10 to find the mean time period for one oscillation. Repeat ~~it an~~ the experiment 3 more times with each mass and obtain a mean value.

(ii) Describe the graph he should plot to obtain a straight line and how to determine the spring constant from the graph.

(3)

$\left(\frac{T}{2\pi}\right)^2 = \frac{m}{k}$ Plot a T^2 against mass graph.

$\frac{T^2}{4\pi^2} = \frac{m}{k}$

$T^2 = \frac{1}{k} m \times 4\pi^2$

$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$

$y \quad m \quad x \quad +c$

spring constant $= \frac{1}{\text{gradient}}$

ResultsPlus

Examiner Comments

In part (i) it is as important to take the actual measurement three times as it is to record the time for a number of oscillations, which the candidate acknowledges.

In part (ii) plotting T^2 against m is a good graph to plot and clearly they were thinking about T^2 over $4\pi^2$ which would also work but they choose their first option and compare it wrongly with the equation of a straight line and thus get the gradient wrong too.

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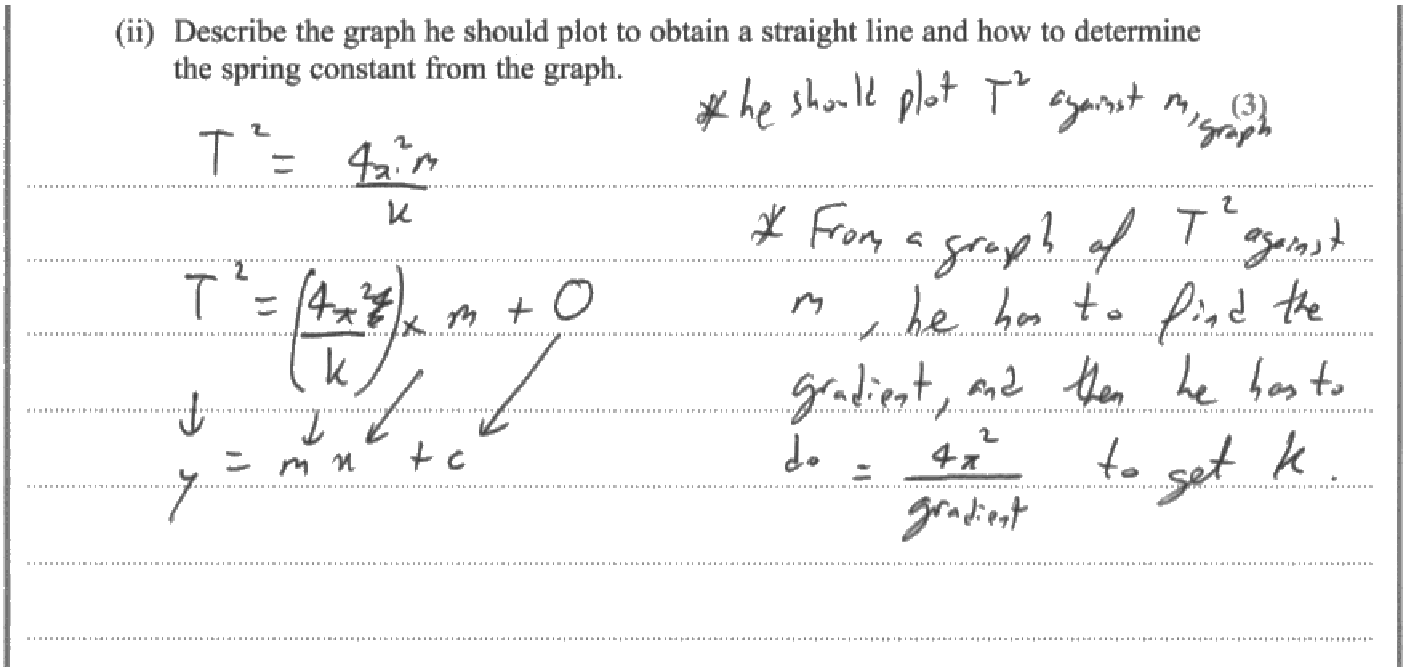
Examiner Tip

Don't change your mind in the middle of an answer without writing it all out again. It doesn't take long.

This candidate gets the right way of doing part (ii).


(ii) Describe the graph he should plot to obtain a straight line and how to determine the spring constant from the graph.

(3)

$T^2 = \frac{4\pi^2 m}{k}$

$T^2 = \left(\frac{4\pi^2}{k}\right) \times m + 0$

$y = m x + c$

* he should plot T^2 against m, graph

* From a graph of T^2 against m, he has to find the gradient, and then he has to do $= \frac{4\pi^2}{\text{gradient}}$ to get k.

ResultsPlus
Examiner Comments

The use of the brackets helps very much to show exactly what they intend to use as the gradient.

ResultsPlus
Examiner Tip

It is a great help to include the zero to show that your graph will have a zero intercept rather than leave it up to the exmainer to decide whether you knew this or not.

Question 2 (b)

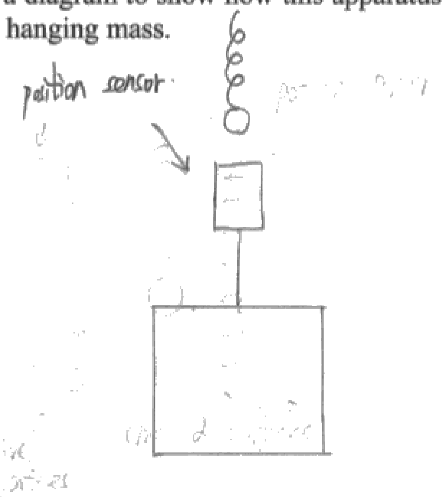
The use of ICT in experiments has been with us for some time now and the appearance of questions such as this should be expected. It seemed that few candidates had thought much about the use of a position sensor rather than a light gate but a light gate is not very good at recording the time for a number of events - it requires unusual software. A position sensor records the position over a period of time rather than individual events and is much more versatile.

This was a good answer but unfortunately not very typical.

(b) His teacher suggests using a position sensor with a datalogger instead of the stopwatch.

(i) Draw a diagram to show how this apparatus could be used to record the position of the hanging mass.

(2)



(ii) Explain how using a position sensor with a datalogger will improve the measurement of the time period.

(2)

① No human reaction time

② Can give more readings during a given time.

③. Can plot the graph automatically.

ResultsPlus
Examiner Comments

This candidate got the mark for placing the sensor in the line of motion of the moving object but failed to indicate what it was connected to.

In (ii) the second bullet point would only be of use if the system had a very high frequency, which is unlikely for a spring-mass system, but the marks were awarded for the other two bullet points.

ResultsPlus
Examiner Tip

Labels for diagrams are vital - always.

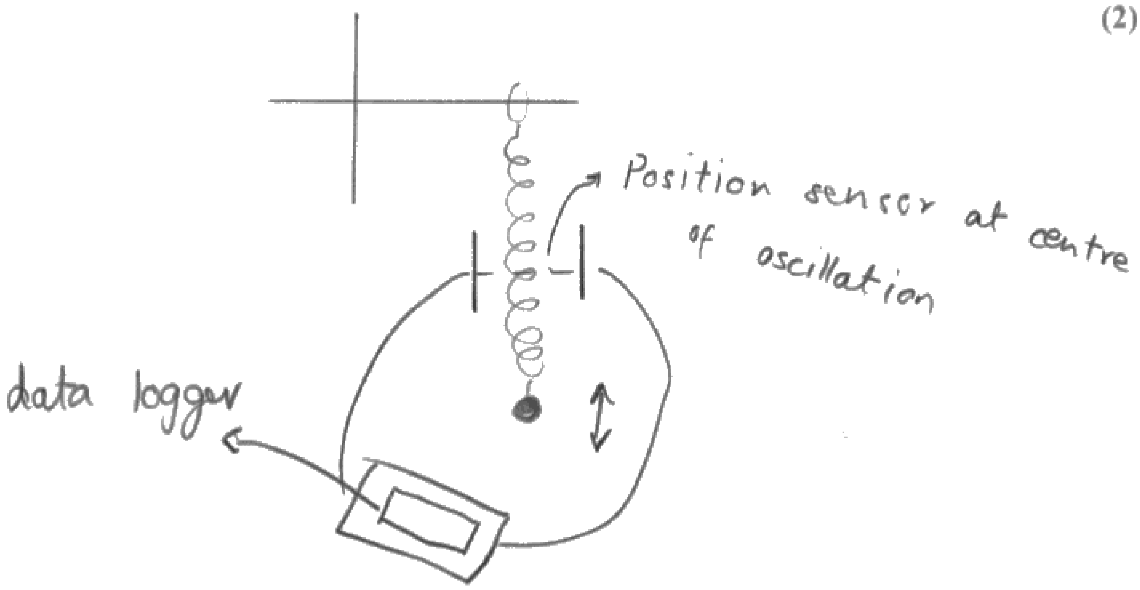
Note too that bullet points are acceptable for this sort of answer which requires a list.

This candidate gets their ideas very muddled up.

(b) His teacher suggests using a position sensor with a datalogger instead of the stopwatch.

(i) Draw a diagram to show how this apparatus could be used to record the position of the hanging mass.

(2)



(ii) Explain how using a position sensor with a datalogger will improve the measurement of the time period.

(2) (0.1 secs)

Data logger has no reaction time as like humans ~~(...)~~ will time accurately to 3 significant figures. It will also take simultaneous readings. Plots graphs automatically. You can place it exactly in the centre of oscillation. Thus timing exact distance.

ResultsPlus

Examiner Comments

The position sensor looks very like a light gate and it is placed at the centre of the oscillation - which means it will count double - but it looks as though it is in an electric circuit of some sort.

Question 3 (a)

To criticise some results is to comment on the good and bad features. A few candidates misunderstood this and described how the potential difference decreased with frequency which is interpreting them rather than criticising. Many correctly said that there were only four readings and many remarked that there was no evidence of repeat readings. There were only four colours available to me when I did this practical and this is a valid criticism but since the frequencies (colours) are fixed by the manufacturer many candidates' critcism that the gaps between the variables was not the same was not valid. This can only be valid when the experimenter has control over the independent variable but even then it is not always necessary since the output might vary non-linearly.

(a) Criticise these results.

(1)

when the frequencys is decreased the potential difference is also being ~~dercreased~~. decreased.

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Examiner Comments

This is a candidate who describes the trend correctly but this is not a comment on the readings themselves.

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Examiner Tip

Ensure you understand what the command terms are asking you to do.

Question 3 (b)

This part of the question is designed to test candidates' ability to fit a line to some data and use the line to produce the value for Planck's constant.

Many candidates joined the top and bottom plot and lost the mark for (i). A line of best fit should have plots on either side and the same number on each side if possible. It is very tempting to draw the line through the most extreme plot - here the top one - and then pivot about that point to fit between the remainder. The top plot is no more significant than the others and so should be treated the same.

Most candidates found the gradient using a large triangle and read the values from the axes correctly. Many then lost sight of the equation and the powers of ten and fewer than half achieved the correct value for the constant either by failing to multiply by *e*, the electron charge, or by misusing the powers of ten. Many lost the final mark by not using 3 SF in their answer; 3 SF is always expected for plotting, gradient work and final values for graph work.

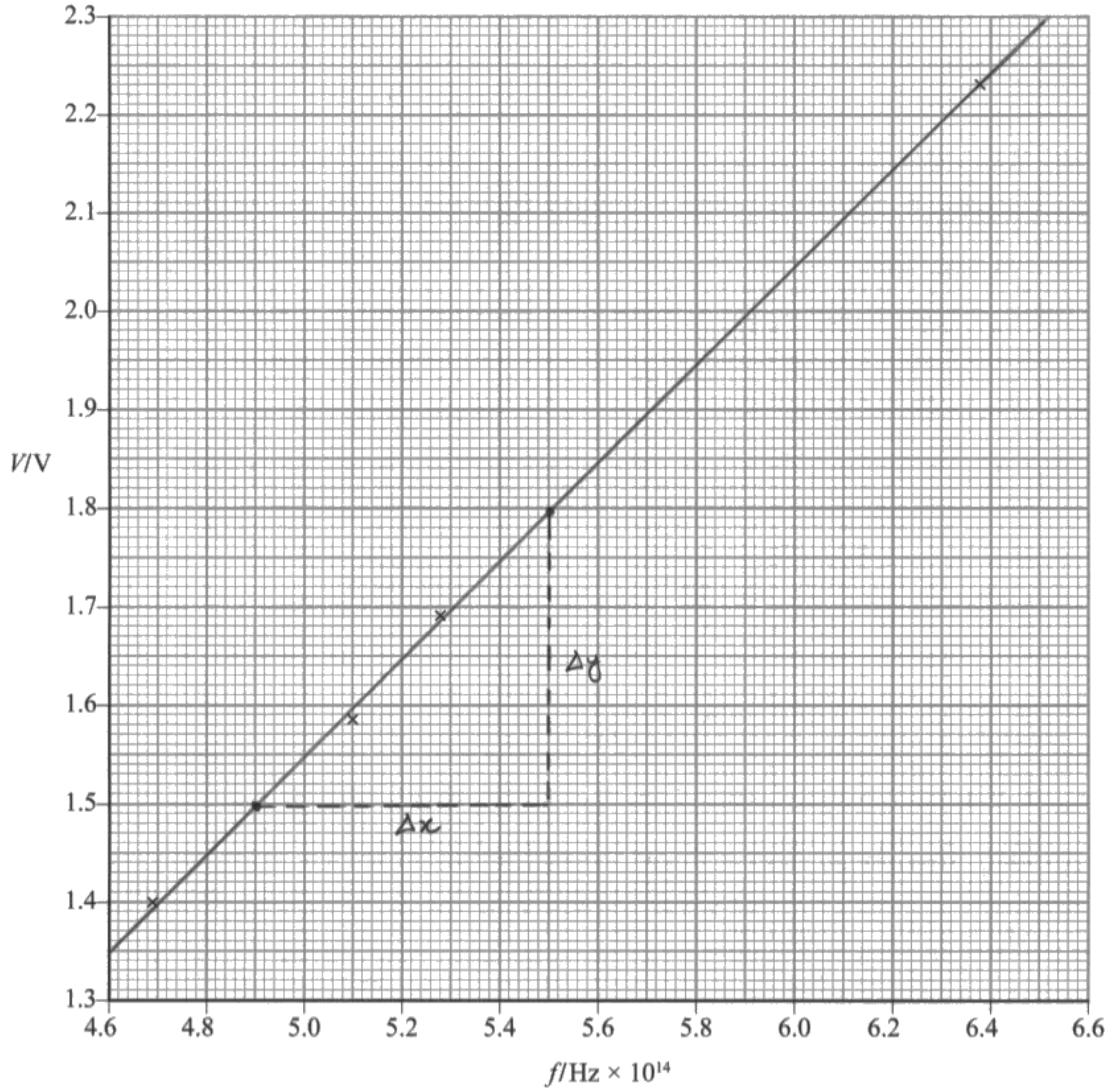
This candidate scores 4 out of 6 but could so easily have done better.

(b) V and f are related by

$$eV = hf - b$$

where e is the electron charge, h is Planck's constant and b is also a constant.

The student plotted a graph of V against f.



(i) Draw a straight line of best fit on the graph.

(1)

(ii) Use the gradient of your line to determine a value for Planck's constant.

(4)

~~Gradient = Δy/Δx = 1.8 − 1.5 / 5.5 − 4.9 = 0.5~~

Gradient $= \frac{\Delta y}{\Delta x} = \frac{1.8 - 1.5}{(5.5 - 4.9) \times 10^{14}} = 5 \times 10^{-15}$

∴ $h =$ gradient $\times e$

$= 5 \times 10^{-15} \times 1.6 \times 10^{-19} = 8 \times 10^{-34}$

Planck's constant = 8×10^{-34}

(iii) Determine the percentage difference between your value and the accepted value of Planck's constant.

(1)

% difference $= \frac{8 \times 10^{-34} - 6.63 \times 10^{-34}}{6.63 \times 10^{-34}} \times 100$

$= 20.67\%$

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Examiner Comments

There is a good line of best fit. It passes just below two of the lower plots but slightly further above the third so that these 'balance'.

The triangle is not large enough. Having small differences in the gradient calculation makes the final result more susceptible to mis-reading and hence a less accurate final value. The triangle should occupy at least half the plotted length or preferably use the whole line.

Having got a decent value for the gradient they only use 1 SF leading to 1 SF in the final answer. Ignoring the powers of ten their gradient calculation gives 0.3/0.6; given that major grid lines are used to obtain these values the gradient should be expressed as 0.500 and 3 SF is justified in being carried through to the final value for *h*.

Along with many candidates (iii) is correct and candidates seem to be good at this sort of calculation.

ResultsPlus

Examiner Tip

Use 3 significant figures in all aspects of graphical work.

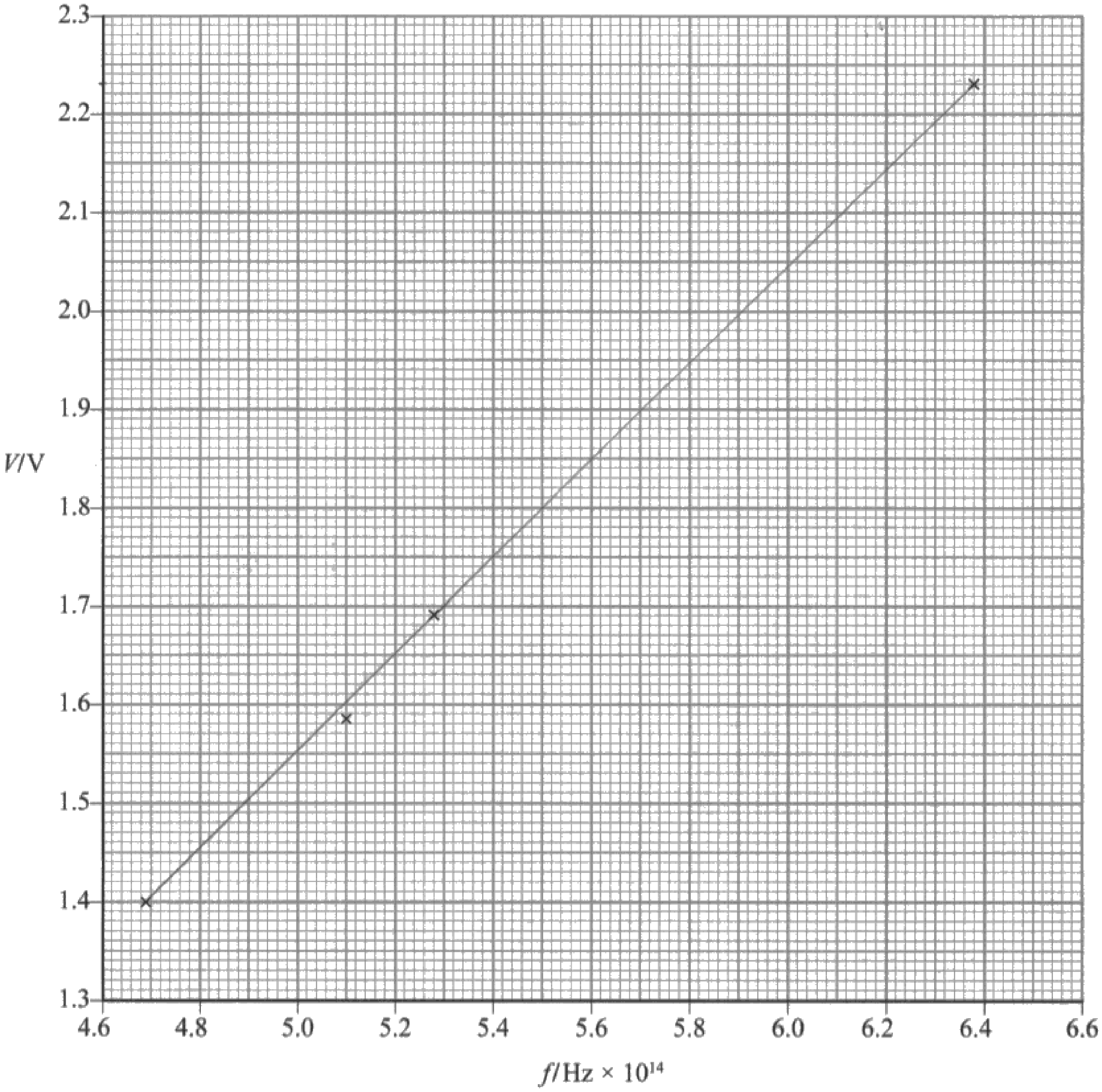
This candidate lost marks in a similarly silly way.

(b) V and f are related by

$$eV = hf - b$$

where e is the electron charge, h is Planck's constant and b is also a constant.

The student plotted a graph of V against f. $V = \frac{hf}{e} - \frac{b}{e}$



(i) Draw a straight line of best fit on the graph.

(1)

(ii) Use the gradient of your line to determine a value for Planck's constant.

(4)

gradient $= \frac{2.23 - 1.4}{(6.38 - 4.69) \times 10^{14}}$ $\quad V = \frac{hf}{e} - \frac{b}{e}$

$= 4.91 \times 10^{-15}$ $\quad \Rightarrow h = 4.91 \times 10^{-15} \times 1.6 \times 10^{-19}$

$= 7.86 \times 10^{-34}$

Planck's constant = 7.86×10^{-34}

(iii) Determine the percentage difference between your value and the accepted value of Planck's constant.

(1)

$\%\ \text{diff} = \frac{(7.86 \times 10^{-34}) - (6.63 \times 10^{-34})}{6.63 \times 10^{-34}} \times 100$

$= 18.6\%$

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Examiner Comments

Their line of best fit joined the top and bottom plot, thus passing through one of the lower plots but leaving one plot on its own. They do not get the mark for (i).

The values used for their gradient calculation are those of the top and bottom plot. This is acceptable as the line was drawn exactly though these points; it is not acceptable to use plotted points when the line does not pass exactly through the point as the candidate is not then using a triangle.

They use 3 SF for their gradient value and for the constant but leave out the unit thus losing the fourth mark.

Again the percentage calculation is correct.

ResultsPlus

Examiner Tip

Consider the units that your gradient value will have when you use it and always ensure your final answer has units compatible with your measurements.
If nothing else use the data sheet to check your answer.

Question 4 (a)

This question asked candidates to design an electric circuit, this is a task that an AS student should be able to do and it was surprising how many candidates dropped a mark. Commonly they used the wrong symbol for the variable resistor but there were more fundamental errors.

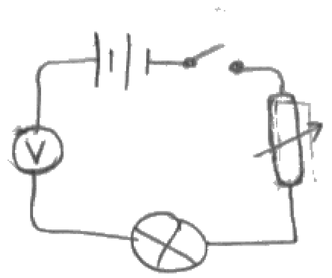
For a relatively simple question, many candidates found it quite challenging.

4 The intensity of light emitted by a light bulb varies with the electrical power supplied.

(a) Draw a circuit diagram of the circuit you would use to vary and determine the electrical power supplied to a bulb.

$P = IV$
$P = I^2R$

(2)



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Examiner Comments

They are asked to measure the power so the absence of an ammeter is wrong but to connect the voltmeter in series is a mistake that should not be made at this level.

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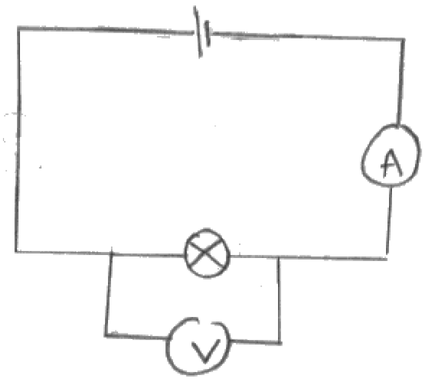
Examiner Tip

Questions at this level draw on knowledge from previous years, so candidates are expected to be able to use knowledge from GCSE and AS.

4 The intensity of light emitted by a light bulb varies with the electrical power supplied.

(a) Draw a circuit diagram of the circuit you would use to vary and determine the electrical power supplied to a bulb.

(2)



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Examiner Comments

Did this candidate spot the word **vary** in the question?

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Examiner Tip

Read the question and underline the command terms, here draw, vary and determine.

Read the question again when you have completed your answer.

Question 4 (b) (i)

This was simple recall of AS knowledge. A very large number of candidates wrote that the resistance increased. Although this is a 'choice of two' question candidates should have a way of remembering such information.

Question 4 (b) (ii)

This was a very tricky question for only one mark. Candidates were awarded the mark for saying something about the intensity varying with distance or that the variable under investigation was the power supplied to the light bulb and so distance must remain the same. Many candidates lost the mark because they gave simplistic answers, for example 'so that there is a fair test'; at this level it is expected that there is appropriate physics in an answer.

This answer nearly didn't get there.

(ii) State why the distance between the LDR and the bulb should remain constant throughout the experiment.

(1)

To keep the intensity of light falling on the LDR constant.

~~The aim of the experiment~~ The aim is to determine intensity as power supply is varied and not the distance between LDR and bulb.

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Examiner Comments

The first line is not enough and is in fact wrong. The purpose of the practical is to vary the intensity not keep it the same - a lot of candidates thought like this and added nothing more.

However this candidate recovers by identifying the true independent variable.

To keep the intensity of light falling on the LDR constant.

~~The aim of the experiment~~ The aim is to determine intensity as power supply is varied and not the distance between LDR and bulb.

ResultsPlus

Examiner Comments

This candidate manages to find precisely the right answer.

As distance increases the intensity decreases.

ResultsPlus
Examiner Comments

This response was also awarded the mark, even without qualifying the reason.

Question 4 (c)

This is the question that discriminates between the candidates most successfully every year. The surprising aspect of this is that it is the usual hazards that cause candidates to lose marks. The label for the logarithm of the power measured in Watts is written ln(*P*/W), this is so that the logarithm is found for a dimensionless number and the logarithm itself has no unit. Candidates usually remember this when considering units for their gradient.

Similarly the gradient must be measured and calculated using a large triangle occupying more than half the plotted length and the line of best fit must have plots on both sides. It is possible to award the mark for the line of best fit but to find the gradient calculation out of tolerance in the last part of the question.

This candidate scores 5 out of 9; with a better choice of scale for the graph this might have been 8.

(c) Values of power *P* and the corresponding light intensity *I* are shown in the table below.

I/W m^{-2}	P/W	ln I	ln P
1900	20.47	7.550	3.014
740	13.09	6.607	2.572
425	11.09	6.052	2.406
220	8.29	5.394	2.115
123	6.37	4.812	1.852
76	5.45	4.331	1.696

It is suggested that *I* and *P* are related by

$$I = kP^x$$

where *k* and *x* are constants.

(i) Show that a graph of ln*I* against ln*P* should be a straight line.

(2)

$I = kP^x$

$\ln I = \ln k + \ln P^x$

$\ln I = x \ln P + \ln k$

$y = mx + c$

(ii) Use the grid opposite to plot a graph of ln*I* against ln*P*. Use the column(s) in the table for your processed data.

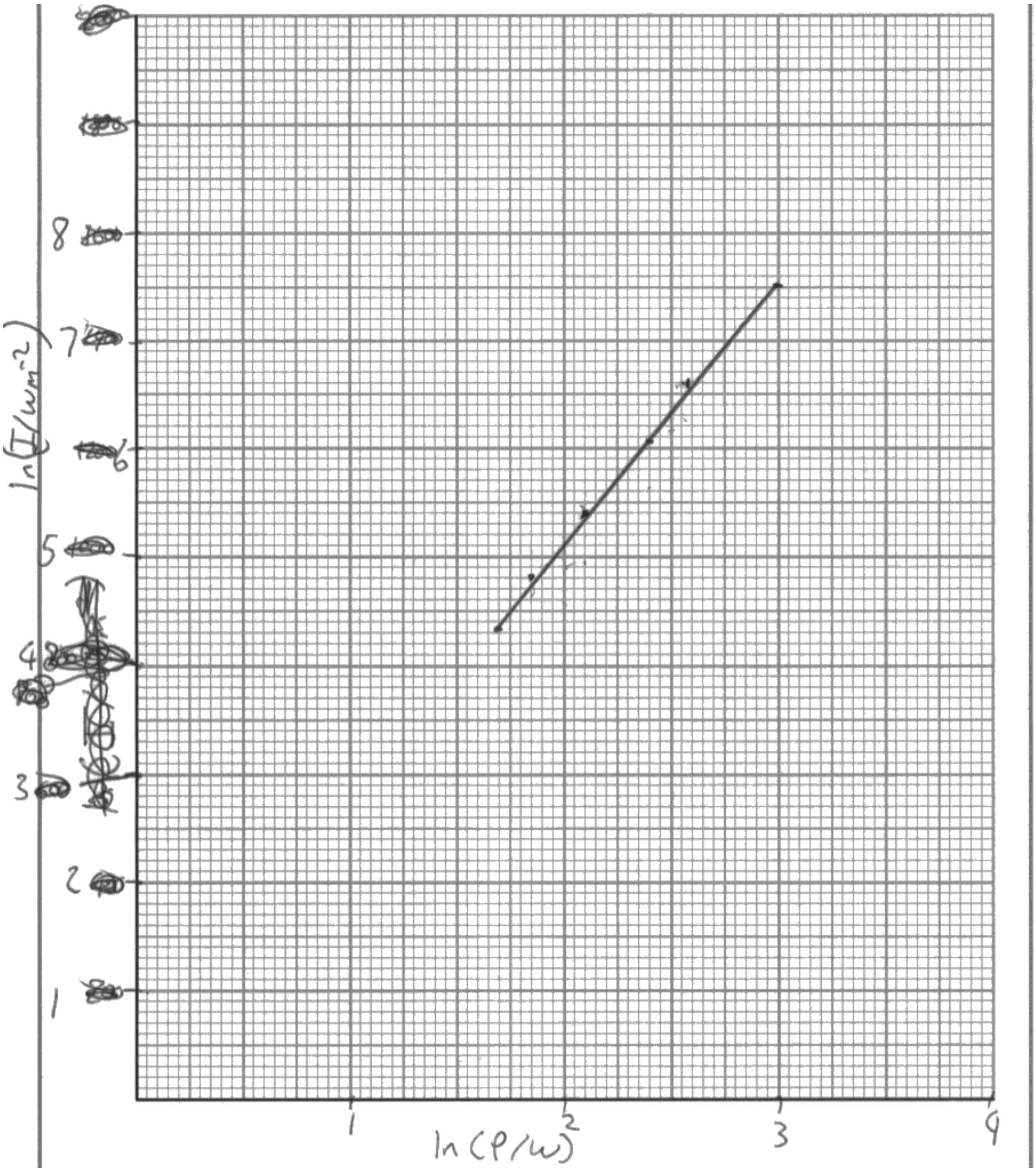
(5)

(iii) Use your graph to determine a value for *x*.

(2)

$$\frac{7.550 - 5.394}{3.014 - 2.115} = 2.38$$

$x =$ 2.38



ResultsPlus
Examiner Comments

We wanted candidates to say that the line was straight because the value determining the gradient was a constant. Almost all candidates got the log expansion correct, however, the comparison with y=mx+c is not always obvious, but in this example it was clear. The candidate then needs to say that since the gradient is given by m, which is a constant, the gradient will be constant and the line straight - here that is missing.

The values in the table are correct but the fourth significant figure is of no use in plotting the points. The labels on the axes are correct and the axes are the right way round. The scale is poor. There is never a need to show the origin (0,0) on a graph unless it is a data point. By including the origin the candidate has compressed the data making it difficult to read and difficult to plot. In fact they get the plots right but the line of best fit has no plots below it so they lose this mark.

In calculating the gradient they use the data values from the table but the line of best fit does not pass exactly though those points so they are not using a triangle. They lose the first mark but get the second since their value is in range and has no unit.

ResultsPlus

Examiner Tip

Choose a scale that spreads the data out across the page, this makes all subsequent actions easier.

(c) Values of power P and the corresponding light intensity I are shown in the table below.

I/W m^{-2}	P/W	ln I / Wm^{-2}	ln P / W
1900	20.47	7.55	3.02
740	13.09	6.61	2.57
425	11.09	6.05	2.41
220	8.29	5.39	2.12
123	6.37	4.81	1.85
76	5.45	4.33	1.70

It is suggested that I and P are related by

$$I = kP^x$$

where k and x are constants.

(i) Show that a graph of $\ln I$ against $\ln P$ should be a straight line.

(2)

$\ln I = \ln p^x + \ln k$

$\ln I = x \ln p + \ln k$

This is similar to $y = mx + c$

(ii) Use the grid opposite to plot a graph of $\ln I$ against $\ln P$. Use the column(s) in the table for your processed data.

(5)

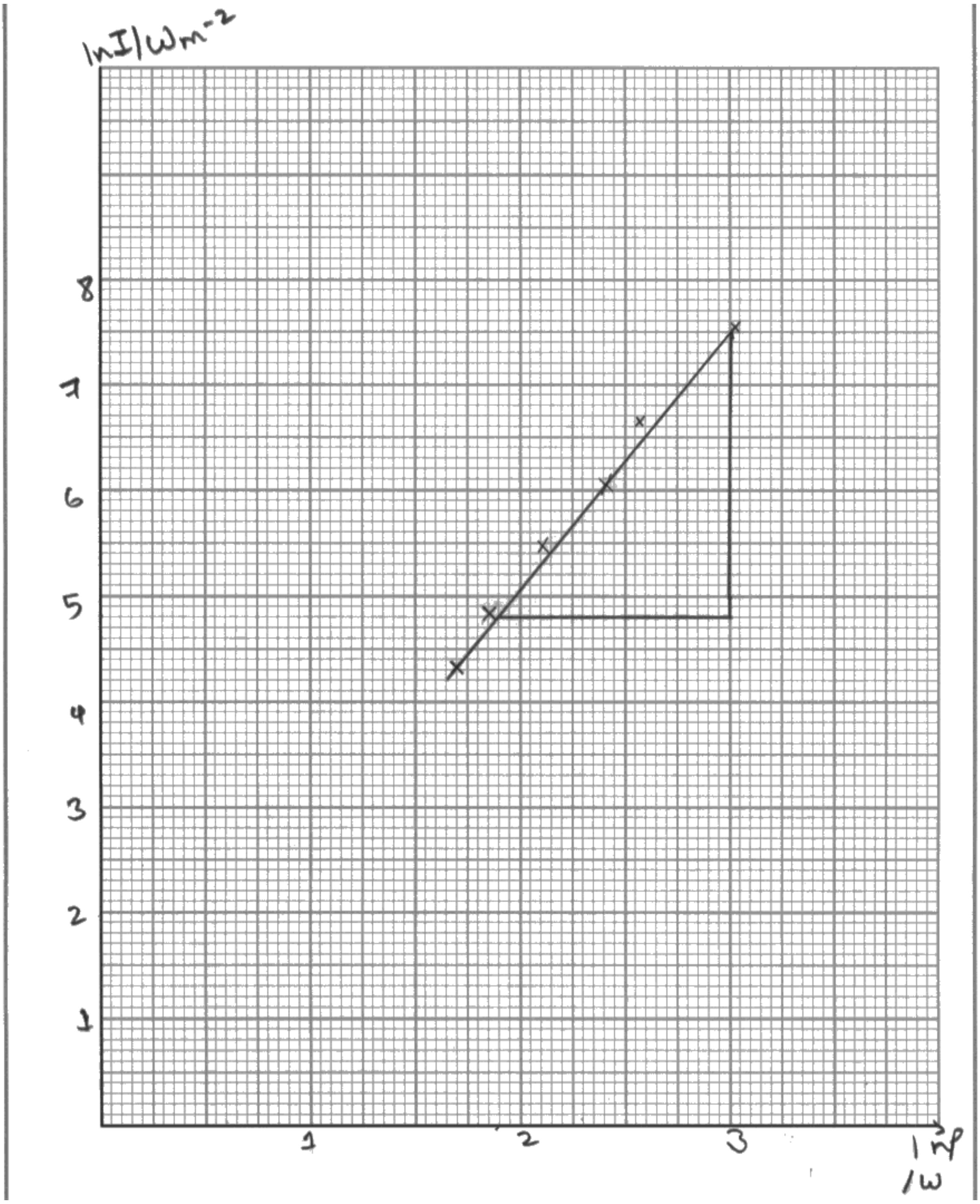
(iii) Use your graph to determine a value for x.

(2)

$x = \dfrac{7.5 - 4.8}{3 - 1.9}$

$= 2.45$

$x =$ ~~2.45~~ 2.45



ResultsPlus
Examiner Comments

There is no indication that the gradient is constant.

The graph itself scores 0 out of 4 because the labels are wrong - they should be ln(P/W) for example - the scale is too small - the origin is included for no reason - the plot at 2.12, 5.39 is at 5.49 ie one small square out and the line of best fit has no plots below it. This candidate seems not to have had much practice plotting graphs.

The gradient triangle is large and correctly read giving a value in range so they score both marks for part (iii).

ResultsPlus
Examiner Tip

Graph work must be practised.

Paper Summary

The paper looked at the range of practical skills but the planning question was more structured and there was more emphasis on conclusion and evaluation.

The first question looked at the uncertainties involved with taking relatively simple measurements of a tin can but considering the effect of subtracting values rather than the usual multiplying or dividing. In this case it is the actual uncertainties that are added but since the two measured values were so close the uncertainty in the resulting small values was very high. The planning question concerned a mass oscillating on a spring and introduced the idea of using a position sensor and data logger; this seemed unfamiliar to the candidates. There were two questions this year on plotting graphs and drawing conclusions, the first required some criticism of the readings and the resulting graph and the second included the design of a simple electric circuit in an analysis of the results of an inverse square law experiment.

Future candidates could improve their results by having more experience in planning practical work and by drawing more graphs and then using the results to evaluate the outcome. All candidates will benefit by seeing and doing practical work however simple.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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