Examiners' Report
June 2016

IAL 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 physics candidates face the same sort of 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)

This question expects the candidate to justify the choice of a measuring instrument by considering the uncertainty it introduces into the measurement. It mirrors the demands for the home centre's coursework.

For the first mark we expected candidates to know that the precision of the instrument is 1 mm. For precision the terms uncertainty, least count, smallest division and minimum reading of metre rule were acceptable. The use of accuracy is not correct as this depends on how the instrument is used rather than the nature of the rule itself.

We then expected a calculation of the percentage uncertainty and a comment on the fact that this is small in comparison with typical uncertainties in an A level laboratory.

This was usually done well although a significant number did not do a calculation and many omitted to comment on the result of 2%.

This is an example of a response that scores only the first mark by identifying the precision of a metre rule.

(a) She measured l_0 using a metre rule and recorded l_0 = 5.2 cm.
Explain why a metre rule is a suitable instrument to make this measurement.

(2)

metre rule makes measurements to a precision of 1 mm, as the precision is much smaller than the measurement, the percentage uncertainty is small.

ResultsPlus
Examiner Comments

This candidate has not calculated the percentage uncertainty introduced by using a metre rule.

ResultsPlus
Examiner Tip

The term 'small' is a comparative one and in a physics paper needs some numerical evidence to support its use.

$\frac{1}{52} \times 100 = 1.92\% = 2\%$ uncertainty

Since percentage uncertainty is small, it is suitable to use this instrument.

ResultsPlus
Examiner Comments

This candidate was fortunate to score the first mark but the term 'small' requires explanation. This answer is worth one of the two marks available.

Question 1 (b) - (e)

This question takes the candidate through an experiment to determine the density of some modelling clay. The intention is that the loading curve for a spring is used to measure the weight of the clay in air and in water. A diagram is part of the question to help the candidate think through their working and the question ends with a comparison with a known value using the uncertainties arising from the measurements.

One of the key points was that the graph showed the length of the spring and not the extension of it; this caught out a few candidates but some used the stiffness, or gradient, and multiplied by their calculated extension. This method works too for the uncertainty in part b(ii). For part b(iii) it was expected that candidates would use their answers from (i) and (ii) in the usual manner. Those who drew lines on the graph at 14.1 cm and 14.5 cm almost always got the marks for the whole of part (b).

Part (c) was generally done well but it was disappointing how many candidates drew poor and inaccurate diagrams, often including a mysterious drag force. Part (d) was intended to be an easy two marks with one for the calculation of the density - with error carried forward - and the other for quoting 3 significant figures (SF) and correct units. Many candidates scored the first mark and equally as many lost the second by either quoting 4 SF or forgetting to multiply by the density of the water.

Part (e) was an exercise in uncertainties and was not done well. Most candidates correctly calculated the percentage difference between their value and the one given (using the paper value as the denominator) but were unable to produce a meaningful uncertainty. The expression used in (d) requires the division of two numbers W_1 by (W_1 - W_2). The correct way to calculate this is to add the actual uncertainties in the two weights and divide this by (W_1 - W_2) to obtain the percentage uncertainty in the denominator and then add the percentage uncertainty in W_1 from b(iii). The key aspect is that there are two quantities being divided and so we accepted a simple doubling of the answer to b(iii) or other similar attempt that used good physics to produce an answer as the sum of two uncertainties. As is usual we allowed the use of uncertainties to produce a range of values for the quantities to see if the ranges overlapped. The conclusion is expected to be based on the numerical reasoning.

The candidate scores the basic marks but does not do enough in later parts.

(ii) The student estimated the uncertainty in l as 2 mm. Use this uncertainty and the graph to estimate the uncertainty in your value for W_1.

(2)

y = mx ~~20~~ ~~2~~

W = 7.14 l ~~0.2×7.14 = 1.43 cm N~~

~~Uncertainity of W_1 = 1.43 cm N~~

% uncertainity = 7.14 x 0.002 = 0.014 N

Uncertainty = ~~1.43 cm N~~ 0.014 N

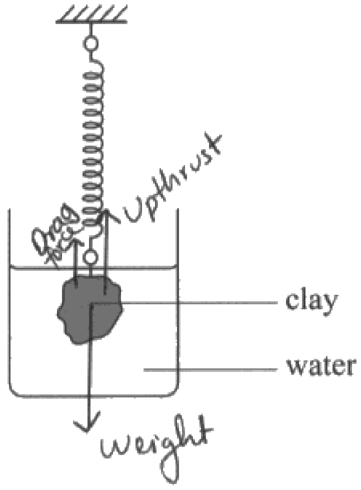
(iii) Calculate the percentage uncertainty in your value for W_1.

(1)

~~= 1.43 / 0.65 × 100~~ percentage uncertainity = 0.014 / 0.65 × 100 = 2.15 %

Percentage uncertainty = 2.2%

(c) The student immersed the clay in water as shown in the diagram. The upthrust of the water on the clay reduced the force of the clay on the spring to a new value W_2 and so l was also reduced.



(i) On the diagram draw and label the three forces acting on the clay.

(1)

(ii) When the clay was immersed the student recorded l = 9.1 cm.

Determine W_2.

(1)

$9.1 \times 10^{-2} = 0.091$ m

W_2 = 0.28 N

(d) The ratio $\frac{\text{Density of clay}}{\text{Density of water}} = \frac{W_1}{W_1 - W_2}$

density of water = 1000 kg m^{-3}

Calculate a value for the density of clay.

(2)

Density of clay = $\frac{0.65}{0.65 - 0.28} \times 1000 = 1756.8$ kgm^{-3}

Density of clay = 1757 kgm^{-3}

(e) The manufacturer's value for the density of this clay is 1680 kg m^{-3}.

Comment on the accuracy of your result.

(3)

% difference = $\frac{1757 - 1680}{1680} \times 100 = 4.58\%$

$= 4.6\%$

Percentage difference (4.6%) is less than the percentage uncertainity (9.4%), therefore the result is accurate.

ResultsPlus

Examiner Comments

The candidate has drawn nothing on the graph.

Having got the value for W_1 correct the candidate uses the gradient and the uncertainty in length to calculate the uncertainty in force and hence the percentage uncertainty in W_1.

The diagram includes a drag force but gets W_2 right.

In (d) the calculation is correct but quoted to 4 SF. In fact the figures used all have zero as their third SF and since these are derived from the graph we expect 3 SF for any numbers used in graph work. For (e) the percentage difference is calculated correctly but compared with 9.4%; without explanation an examiner will make no assumptions about this figure, so the candidate does not score the last two marks.

ResultsPlus

Examiner Tip

Explain what you are doing, unless the numbers come from earlier in the question, then the examiner can be sure you get the marks you deserve.

Don't expect the examiner to guess.

This candidate scores nearly all the marks but still makes one error which is perhaps a misunderstanding.

(ii) The student estimated the uncertainty in l as 2 mm. Use this uncertainty and the graph to estimate the uncertainty in your value for W_1.

(2)

At, $l = 0.141$ m At, $l_2 = 0.145$ m

$W =$ ~~0.64 N~~ 0.635 N $W =$ ~~0.67 N~~ 0.665 N

$\therefore$ Uncertainty $= \frac{0.665 - 0.635}{2}$

$= 0.015$ N

Uncertainty = 0.015 N

(iii) Calculate the percentage uncertainty in your value for W_1.

(1)

% Uncertainty $= \frac{0.015}{0.65} \times 100\%$

$= 2.3\%$

Percentage uncertainty = 2.3%

(d) The ratio $\frac{\text{Density of clay}}{\text{Density of water}} = \frac{W_1}{W_1 - W_2}$

density of water = 1000 kg m^{-3}

Calculate a value for the density of clay.

(2)

Density of clay = Density of water × $\frac{W_1}{W_1 - W_2}$

$= 1000 \times \frac{0.65}{0.65-0.28}$

$= 1800$ kg m^{-3}

Density of clay = 1800 kg m^{-3}

(e) The manufacturer's value for the density of this clay is 1680 kg m^{-3}.

Comment on the accuracy of your result.

(3)

% Difference = $\frac{1800-1680}{1680} \times 100\% = 7.14\%$

The uncertainty in W_2 ~~which~~ ~~remains~~ same as W_1. So uncertainty in $W_2 - W_1$

is : 0.015 + 0.015 = 0.03 N . So % Uncertainty in $W_1 - W_2 = \frac{0.03}{0.65-0.28} \times 100\% = 8.11\%$

∴ Total ~~per~~ % Uncertainty in ~~the~~ density is = 2.3 + 8.1 = 10.4%

As ↑% Uncertainty >> % Differenty result is valid.

ResultsPlus
Examiner Comments

In part b(ii) the candidate shows where the uncertainty in length gives the values for the uncertainty in force. They could have done that by drawing on the graph but the examiner is in no doubt where the numbers come from - no guessing! The uncertainty is used correctly to arrive at 2.3%.

This candidate quotes their density to 2 SF when 3 is appropriate because the number comes from a graph. So part (d) scores 1 only but the value of 1800 is carried forward to part (e).

This candidate shows that they understand well the way to use uncertainties and gives an exemplary answer with good reasoning shown for three marks.

ResultsPlus
Examiner Tip

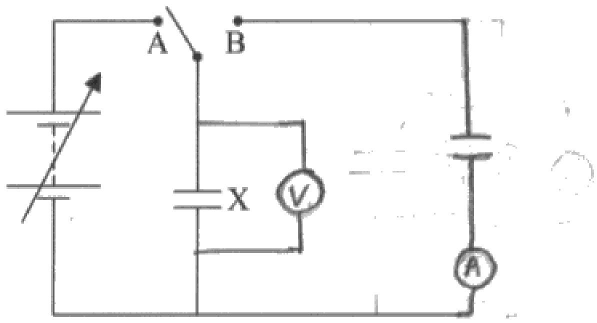
Always use 3 SF for numbers on graphs - for plotting, measuring gradients, quoting gradient values and, when necessary, interpolating values for future use.

Question 2 (a)

Most candidates could show the correct connections for the capacitor and voltmeter with the common error being a voltmeter in series.

It is not a good idea to add components in addition to those stipulated in the question. Usually the examiner will ignore extras unless they stop the circuit doing what is required by the question, in which case the marks are lost.

2 Part of an electric circuit is shown.



When the switch is connected to terminal A the capacitor X is connected to the variable power supply.

(a) (i) Add a second capacitor Y to the circuit so that it is connected in parallel with X when the switch is moved to B.

(1)

(ii) Add a voltmeter so that the potential difference (p.d.) across X can be measured when the switch is in either position.

(1)

ResultsPlus
Examiner Comments

When the switch is moved to B the two capacitors are connected in parallel - in effect in parallel with the voltmeter too - and so the voltmeter in the position shown will successfully record both potential differences. This candidate scores both marks because the circuit still does what is asked and the ammeter has no effect and so is ignored.

Question 2 (b)

This is a standard capacitor question requiring the candidate to plan an experiment in charge sharing, although some candidates wanted to measure times for charging. It seemed that this experiment was quite well known and answers were generally good although few scored the precaution marks for safety and accuracy.

Many candidates missed the significance of the variable nature of the power supply which enables a range of readings to be taken but a great many candidates understood that there were two potential differences to be measured and how they might achieve this. The graph work in b(ii) was done well although a surprisingly large number of candidates wanted to plot C_X as one of the variables.

Some candidates rearranged the equation to plot V_1 against V_2 and derived a different expression for the gradient. If the gradient expression was correct for the axes chosen the candidate was awarded the mark.

For safety the capacitor should not be charged above its rated voltage and if connected wrongly they can explode! Finally C_Y should be discharged after each episode so that it is empty when the next charge is shared, otherwise it starts with a potential difference between the plates.

The question is marked holistically which means that while it is preferred that candidates answer the question parts in the order set they are not penalised if they don't - the examiner will read the whole answer and write in their marks where appropriate.

This candidate has scored a maximum of 6 marks and there a various ways this can be done. It is always a help to the candidate when writing their answer, to structure it in the order they might do the work.

i) We would take a reading of the voltage when X is connected to the power supply (V_1).
Then we take a redding of the voltage of X when switch is at B and connected to Y. (V_2)
Then we should change the voltage of the power supply and repeat the ~~readings~~ measurements.

ii) $V_2 = \frac{C_x}{C_y}(V_1 - V_2)$

∴ plot a graph of V_2 against $V_1 - V_2$

~~$V_2 = \frac{C_x}{C_y}(\ldots)$~~

$V_2 = \frac{C_x}{C_y}(V_1 - V_2)$

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

$\frac{C_x}{C_y}$ is the gradient which are both constants and therefore it would give a straight line.

$m = \frac{C_x}{C_y}$ C_x is known ∴ $C_y = \frac{C_x}{m}$

iii) The voltage supplied to ~~capacitors~~ capacitors from the power supply shouldn't ~~exceed~~ be very large (max. 6V) ~~(below~~ (below the breaking voltage of the capacitors)

iv) allow ~~the~~ both capacitors to discharge completely and repeat the experiment to take average.

ResultsPlus

Examiner Comments

The first three paragraphs making up the answer to (i) show a clear line of thought. This scores both marks.

For (ii) this candidate shows very clearly how the equation is related to that of a straight line y = mx + c. They then quote the expression for the gradient and point out that both values of capacitance are constant and so the line has a constant gradient - it is a straight line.

Part (iii) is clear enough and the comment in (iv) about discharging is not very convincing since a positive action is required but the idea is clear enough for the mark.

Question 3 (a) (iii)

This question is about the use of graphs. It is important to answer the question precisely and to fill in all the gaps; a number of candidates scored one mark by missing out a link.

The velocity time graph is not a usual way of showing simple harmonic motion and that made this question a little more tricky.

(iii) Explain why the graph has a horizontal tangent at $t = 0.80$ s.

(2)

It is the turning point of the graph, where the pendulum has no displacement.

ResultsPlus
Examiner Comments

This candidate is not wrong in what they say but it fails to address the question. The candidate mentions displacement which is not mentioned in the question so there must be an additional link if this is to contribute to their answer. The turning point must be related to the velocity or the acceleration.

(iii) Explain why the graph has a horizontal tangent at $t = 0.80$ s.

(2)

At t = 0.80 s, the mass reaches a maximum velocity and no longer accelerates (acceleration = 0)
Since the slope = acceleration ≡ 0, a horizontal tangent with 0 slope exists at t = 0.80s.

ResultsPlus
Examiner Comments

This candidate successfully links the graph with the motion of the pendulum. The slope of the graph is the acceleration which is zero is the link needed. Here the candidate mentions both.

ResultsPlus
Examiner Tip

While answering the question, keep in mind exactly what the graph is showing - here it is velocity and time. Hence the slope is acceleration.

Question 3 (a) (i) - (ii)

This question asks the candidates to interpret data from a graph of an oscillating object. One half cycle is shown on the graph so this question tests their ability to use their knowledge of simple harmonic motion.

The answer for (i) is 3.2 s or twice the time shown on the graph. It is at the centre after 0.8 s.This was answered well by the candidates.

(a) (i) Determine the time period T of the pendulum.

(1)

1·60

$T =$ 1·60 s .

(ii) State the value for t when the pendulum is at the centre of the oscillation.

(1)

$t =$ 0·80 s .

ResultsPlus
Examiner Comments

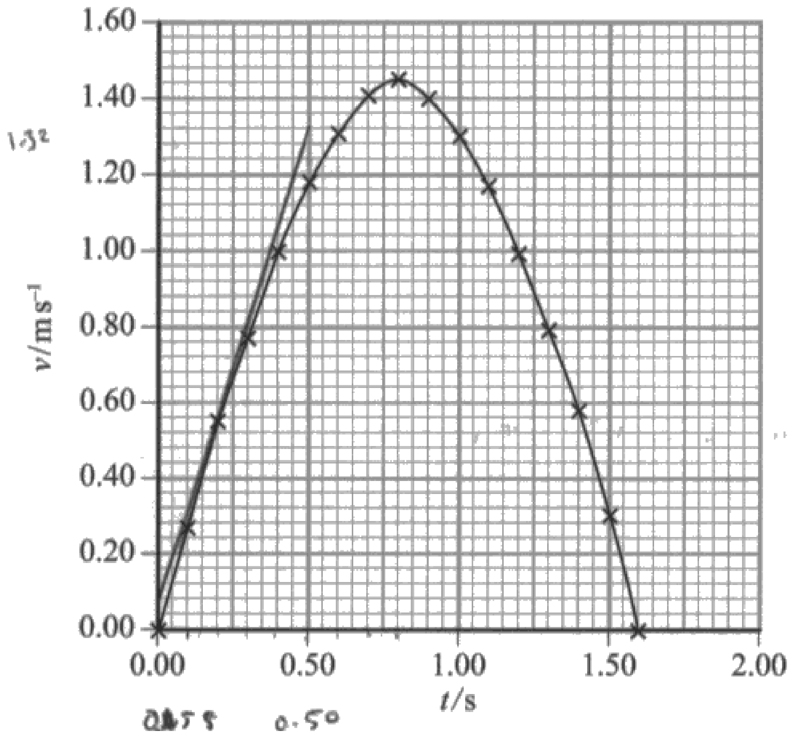
A common error was to think the graph showed all the motion considered in the question.

ResultsPlus
Examiner Tip

There were unit errors for these quantities. Don't forget your units.

Question 3 (b) (i)

Drawing a tangent to a graph is a skill not often practised. Quite a number of candidates drew their tangents at *v*/m s^{-1} = 0.4 which lost them both marks. Generally the measurements from the graph were accurate and the calculation correct so few candidates will have scored only one mark.



(b) (i) Draw a tangent to the graph at t = 0.40 s and use it to calculate the acceleration at this point.

(2)

$m = \frac{y_1 - y_2}{x_1 - x_2}$ $m = \frac{0.40\,ms^{-1} - 1.32\,ms^{-1}}{0.15\,s - 0.50\,s}$

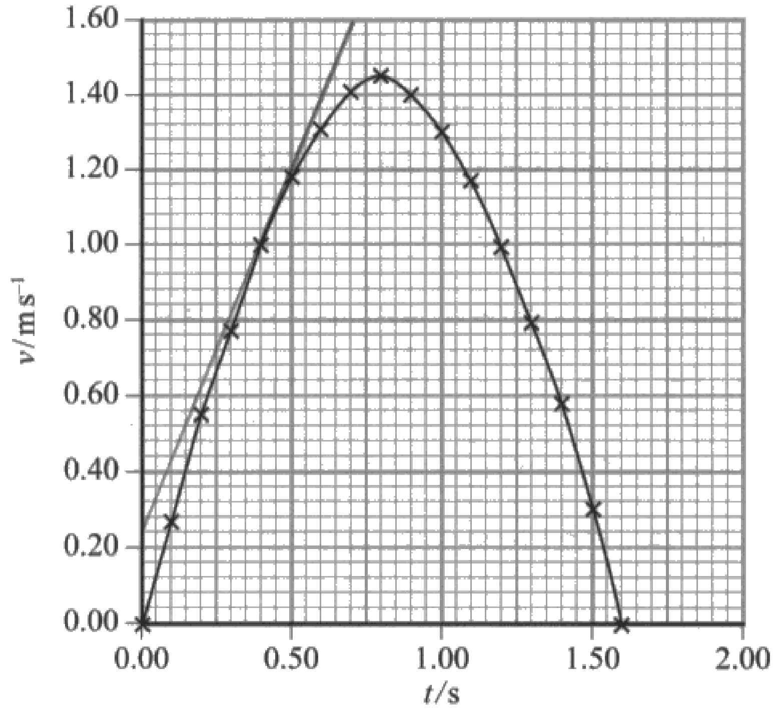
$= 2.63\,ms^{-2}$

Acceleration = $2.63\,ms^{-2}$

ResultsPlus

Examiner Comments

This candidate has tried to draw a tangent at *v*/m s^{-1} = 0.4 but has not made a very good attempt at that and the coordinates for the calculation are rather optimistic. The calculation is correct for the line drawn but shows a big difference from the expected value of 2.



(b) (i) Draw a tangent to the graph at $t = 0.40$ s and use it to calculate the acceleration at this point.

(2)

$a = \frac{\Delta v}{\Delta t} = \frac{1.6 - 0.24}{0.7 - 0} = 1.94 \text{ m/s}^2$

Acceleration = 1.94 m/s²

ResultsPlus
Examiner Comments

This candidate makes a good job of gradient drawing, measurement and calculation with unit.

ResultsPlus
Examiner Tip

Extend your line of best fit to the edges of the grid. This makes two of the four measurements really easy to make. Here v/m s^{-1} = 1.60 at the top and t /s = 0 at the side.

Question 3 (b) (ii)

The answer of 1.20 s was realised by the majority of candidates. It was important to include a unit and at least 2 significant figures.

Question 3 (c)

The advantages of using ICT in your physics experiments are many and can depend on circumstances.

Key aspects are that a data logger can record readings simultaneously and, as in the case here, record many readings in a short time interval - here every 0.1 second.

Answers should reflect the question and it is seldom that the ability to draw a graph will be applicable. Advantages of significance to the context of the question should be described.

(c) State **one** advantage of using a data logger.

(1)

Can take ~~[crossed out]~~ multiple readings at the same time.

ResultsPlus
Examiner Comments

This is a good answer.

(c) State **one** advantage of using a data logger.

(1)

~~(Graph is automatically plotted)~~ Many readings can be taken in a period of time which are automatically plotted on a graph.

(Total for Question 3 = 8 marks)

ResultsPlus
Examiner Comments

This is another good answer.

Question 4 (a)

This is the standard question about plotting data so that a straight line of best fit is achieved. There are two marks so it is important to answer the question fully. This says 'Explain why a graph of .... produce a straight line'.

It is best for the candidates to learn how logarithms work rather than learning lots of examples as an examination question is unlikely to contain an equation that the candidate will have seen before.

There are many ways of getting this wrong and the final example gets it all right.

(a) Explain why a graph of ln I against $1/T$ should produce a straight line.

(2)

$I = I_0 e^{-\frac{P}{T}}$

or, $\ln I = -\ln \frac{P}{T} + \ln I_0$

or, $\ln I = -\ln P \cdot \frac{1}{T} + \ln I_0$

∴ $y = mx + c$. The graph is a straight line, gradient = $-\ln P$

ResultsPlus

Examiner Comments

Here the candidate remembers wrongly and does not see their mistake. The log expansion is wrong so no marks.

$I = I_0 e^{-P/T}$

$\ln I = \ln I_0 - \frac{P}{T}$

$\ln I = -\frac{P}{T} + \ln I_0$

$\ln I = -P \times \frac{1}{T} + \ln I_0$ Y-intercept is $\ln I_0$

$y = mx + c$

Gradient is equal to the constant (p) so the graph will be straight line

ResultsPlus

Examiner Comments

The log expansion is correct for the first mark but the gradient is negative, so *m* = -*p*

(2)

$I = I_0 e^{-\frac{p}{T}}$ $\therefore c = \ln I_0$

$\ln I = \ln I_0 - \frac{p}{T}$ $m = -\frac{1}{T}$

$\ln I = \frac{-p}{T} + \ln I_0$ $\therefore \ln I \propto \frac{1}{T}$

$y = mx + c$

ResultsPlus
Examiner Comments

This shows why the candidate must do more than write y = mx + c underneath their log expansion.

There is further confusion in that there cannot be a proportional relationship due to the presence of a third term in the equation and certainly a variable will not be proportional to the gradient.

A poor answer but they got the log expansion right for one mark.

(2)

$I = I_0 e^{-\frac{P}{T}}$

$\Rightarrow \ln I = \ln I_0 + \ln e^{-\frac{P}{T}}$

$\Rightarrow \ln I = -P \times \frac{1}{T} + \ln I_0$ Similiar to $y = mx + c$.

$m = -P$, P being constant, graph will be straight line

ResultsPlus
Examiner Comments

Finally a correct expansion and good analysis. It helps to mention that *p* (in this case) is a constant and hence the gradient is constant and the line a straight one.

Question 4 (b)

This question asks the candidates to plot some data and use the graph to draw conclusions and evaluate a value for the outcome. It is the standard sort of data handling expected of physics students at this level.

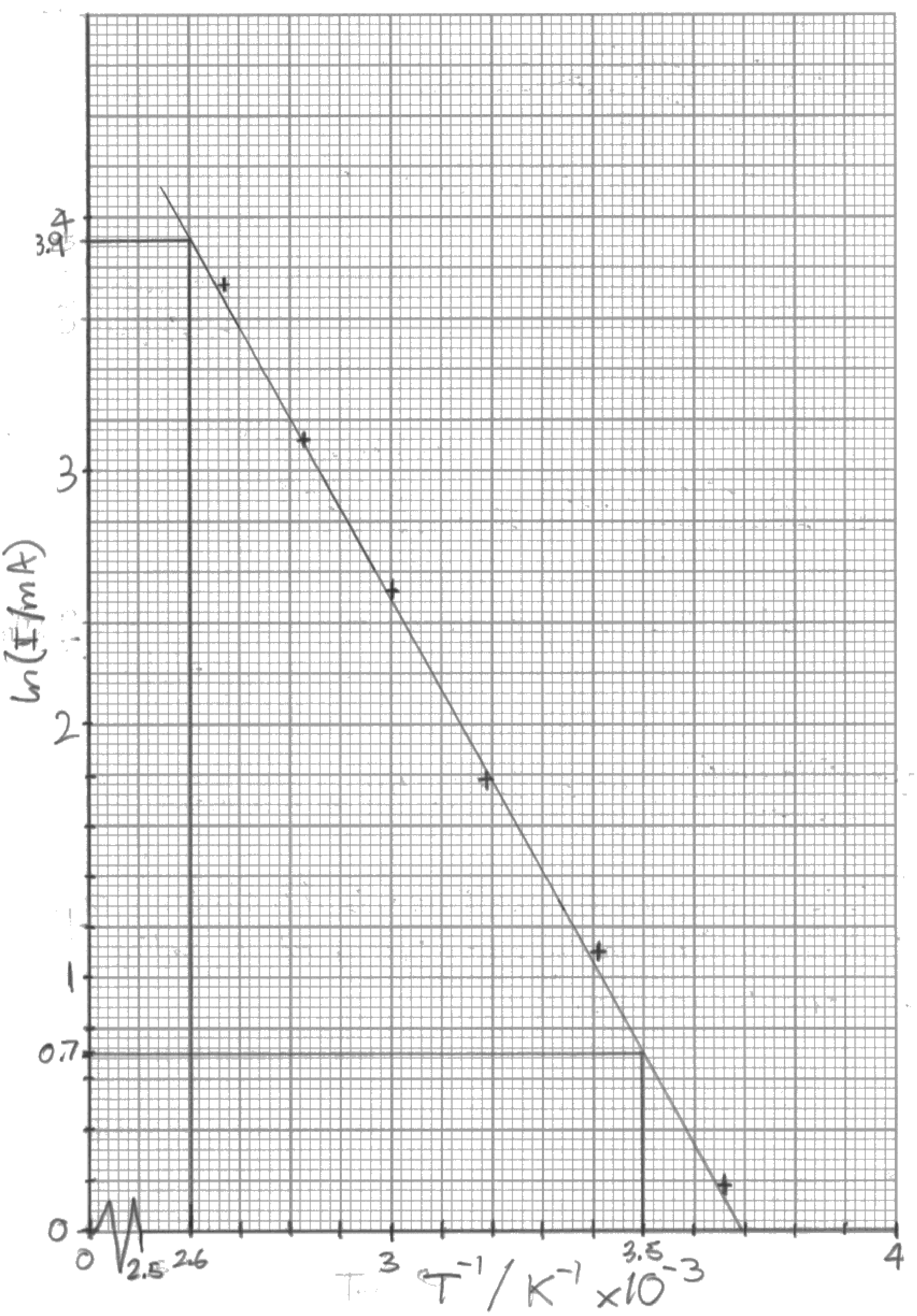
This time the context is that of a diode in forward bias whose temperature is varying. The dependent variable is the current at constant bias voltage.

The standard of graph plotting remains rather variable; it seems that candidates have not rehearsed the business of drawing axes and plotting points in the right place. It is an essential skill for a physicist even when sophisticated graph plotters exist.

In determining a value for p nearly all candidates correctly drew a large triangle and scored the first mark but lost the second. Whilst a gradient might have no units the constant p does and the question asks for a value for p. Here the appropriate unit is K (kelvin); nearly all candidates omitted this. Similarly p is positive. Also some candidates missed the power of 10 from the $1/T$ axis.

Many candidates also lost the mark for (iii) by omitting the unit of Coulomb for the electron charge.

This candidate presented a correct, and neat, table of data - not shown here. The graph is good but the subsequent analysis shows typical mistakes.



(ii) Use your graph to determine a value for p.

(2)

gradient $= \frac{\Delta y}{\Delta x} = \frac{3.9 - 0.7}{(3.5-2.6)\times 10^{-3}} = 3.56 \times 10^3$

gradient $= -p$

$\therefore$ $p = -$gradient $= -3.56 \times 10^3$

$p = -3.56 \times 10^3$ or -3560

(iii) Theory suggests that the electron charge e is given by $e = \frac{kp}{V}$

where k is the Boltzmann constant and $V = 0.32$ V.

Calculate a value for e.

-1.53525×10^{-19}

(1)

$e = \frac{1.38\times 10^{-23} \times -3560}{0.32} = -1.5 \times 10^{-19}$

Since V is 2sf, quote answer 2sf

$e = -1.5 \times 10^{-19}$

(iv) Comment on the accuracy of the result.

(2)

$\frac{-1.6\times 10^{-19} + 1.5\times 10^{-19}}{-1.6\times 10^{-19}} \times 100 = 4.0\%$. Difference from true value

This is a fairly accurate result as this 4% difference can likely be accounted for by errors in temperature readings or the ammeter readings.

ResultsPlus
Examiner Comments

The graph scores all 3 marks. It is clearly drawn using a sharp pencil. The axes are clearly labelled in the expected manner with the power of ten correctly shown on the 1/*T* axis. The scales are values easily read and interpolated and this makes it much easier to plot the points correctly. The line of best fit might be moved upwards very slightly but it will not benefit from rotation.

In the analysis the candidate uses a large triangle to measure the gradient of the line of best fit, as can be seen from the graph or the calculation. Although the gradient calculation is in the range on the Mark Scheme, the candidate has decided it is negative and has omitted a unit thus losing the second mark. The calculation for the electron charge is correct, we allowed 2 SF on this because the forward bias potential *V* is given to 2 SF only but there is a missing unit so this mark is also lost.

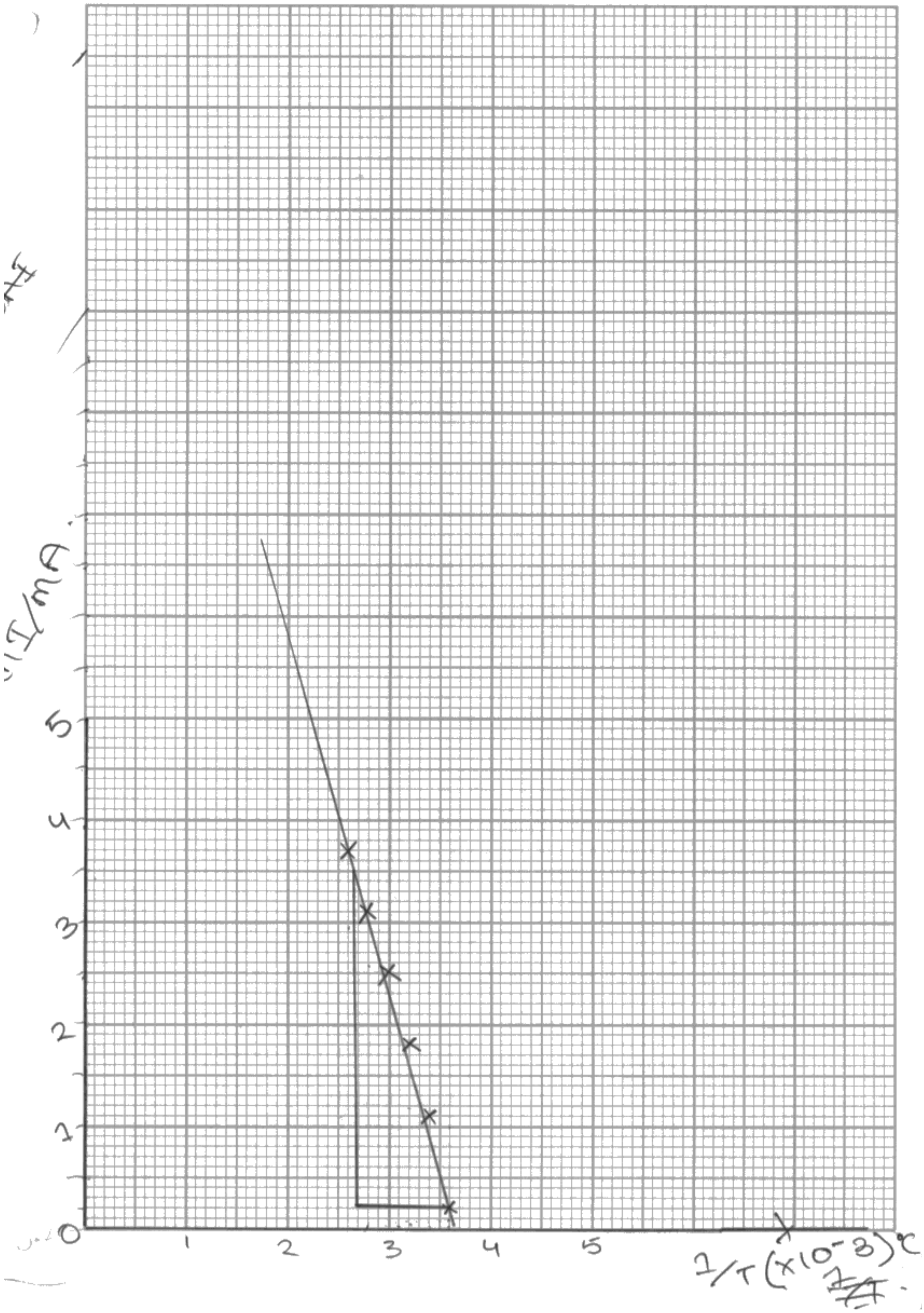
Their value for *e* is correctly calculated by having the book value in the denominator but 4% needs explanation with some numbers. So if measurements in the practical are to be considered then some use of the data table is expected rather than a simple reference to the readings. It is enough here to consider the sort of uncertainties the candidate will have experienced in the laboratory during routine practical work and 4% compares well with these which might range from 5% to 10% in good experiments.

ResultsPlus
Examiner Tip

Show your data to its best advantage by having the right tools and drawing a clear graph.

This candidate is finding great difficulty in plotting a graph for the data.

θ/°C	I/mA	ln I/mA.	~~1/~~T(k)	1/T
0	1.2	0.2.	~~N/A~~ 273	3.6×10^{-3}
20	3.0	1.1.	~~0.05~~ 293	3.40×10^{-3}.
40	6.0	1.8	~~0.025~~ 313	3.20×10^{-3}
60	12.5	2.5	~~0.02~~ 333	3.0×10^{-3}.
80	22.6	3.1.	~~0.0125~~ ~~353~~	2.8×10^{-3}.
100	41.7	3.7.	373.	2.6×10^{-3}.


I/mA
0
1
2
3
4
5
1/T (×10⁻³)

ResultsPlus

Examiner Comments

As mentioned elsewhere, data for graphical work should be quoted to 3 SF. Although some of the original data is to 2 SF when the derived values are plotted 3 SF is appropriate for use on the graph paper. It can be hard to read corrected numbers and so a mis-plot is likely.

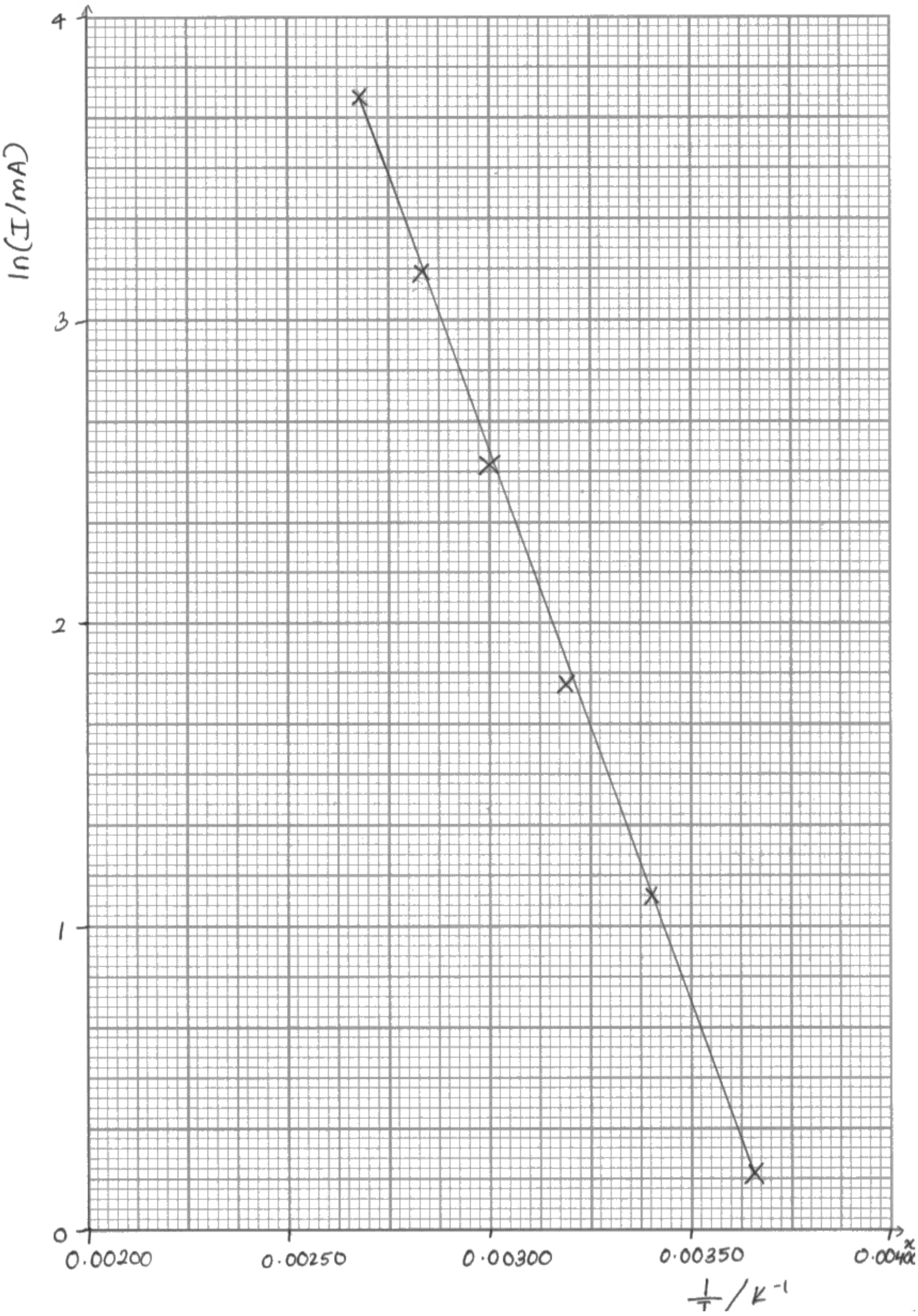
The graph has poor scales on both axes. The data is cramped and difficult to read. Although the gradient is very close to being within range this is a poor graph. The labels are wrong: on the y-axis it should read ln(I/mA) and there are degrees centigrade on the x-axis.

With a few simple changes this graph could look like the first.

ResultsPlus

Examiner Tip

Mistakes are not uncommon but it is bad practice to correct them by writing over the numbers with other numbers. Draw new columns with the correct numbers.



ResultsPlus
Examiner Comments

Finally,

this is quite a good looking graph but the vertical scale is in multiples of 6 and it is very difficult to plot the values correctly or to interpolate data. The units on the axes are right though.

Paper Summary

The paper this year looked at the range of practical skills but the planning question was more structured than usual and there was more emphasis on conclusion and evaluation. The first question looked at the uncertainties involved with taking relatively simple measurements from a graph and then using the data and the uncertainties to reach a conclusion; candidates showed the ability to work coherently through this relatively long question. The planning question concerned a capacitor sharing its charge; this seemed reasonably familiar to the candidates though a large number were clearly thinking about discharging exponentially. There were two questions again this year on graph work; the first presented a relatively unusual graph for analysis that included drawing a tangent but the second was a more familiar format requiring the customary skills although the context was probably unfamiliar to most candidates.

Future candidates could improve their results by:

- having more experience in planning practical work
- drawing more graphs
- 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:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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