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Examiners' Report
June 2010

GCE Physics 6PH08

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Introduction

This unit was available for the first time in June 2010, for the specification which was introduced for first teaching in September 2008. It follows on from the AS paper which was first used in June 2009 and aims to develop the skills required there. It follows the style of the Practical paper set as PHY5 in the previous legacy specification and these papers provide an archive of useful material for training students in the skills to be examined.

The questions aim to cover, as far as possible, the skills criteria from 6PH06, which can be found in the specification, on the Physics subject page of the Edexcel website.

The essential elements are planning and analysis and the marks will divide roughly 20 for each element.

Question 1(a)

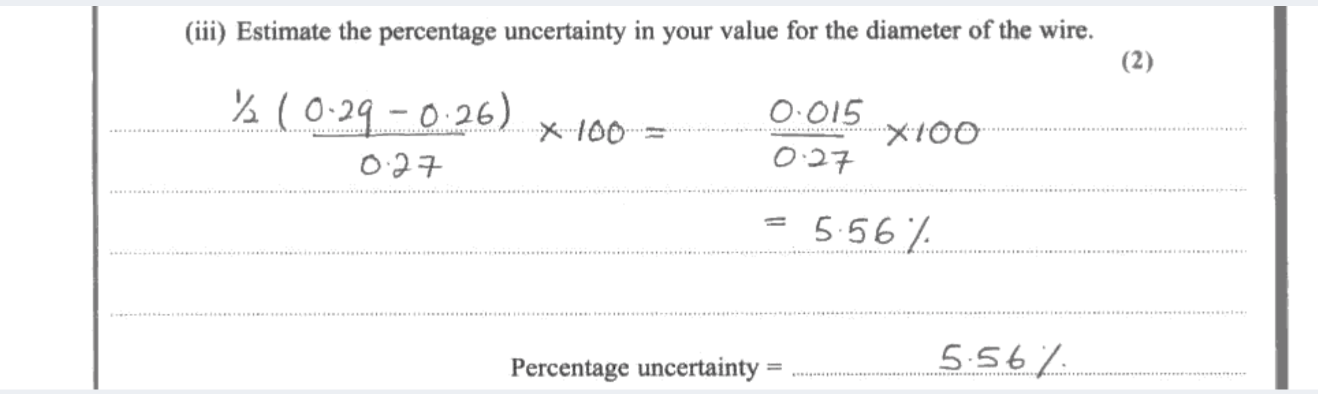
This whole question is about data handling and uncertainty and using that data to reach a conclusion.

i) Candidates were expected to use the word anomaly in their answer which highlighted the misreading of a micrometer by one complete turn of the spindle.

ii) Most candidates were able to get the right answer of 0.27 mm. Those that used all 5 readings to get the answer lost this mark but were able to access all subsequent marks.

iii) Very many candidates used 0.01 mm as the uncertainty - this is not correct. The precision of the instrument is only the uncertainty in the measurement when all the readings are the same. When there is a spread of readings - as in this question - the uncertainty is best taken as half the spread or 0.5(maximum reading - minimum reading).

Repeat readings are used to produce a mean and an uncertainty giving greater reliability.



(iii) Estimate the percentage uncertainty in your value for the diameter of the wire.

(2)

$\frac{\frac{1}{2}(0.29 - 0.26)}{0.27} \times 100 = \frac{0.015}{0.27} \times 100$

$= 5.56\%$

Percentage uncertainty = 5.56%

This candidate has ignored the amalous 0.77 mm and correctly found the mean as 0.27 mm. The uncertainty is taken as half the range, it could equally be the whole range. This is correctly divided by the mean and the resulting percentage need only be to 1 SF.
Uncertainty comes from the range of readings

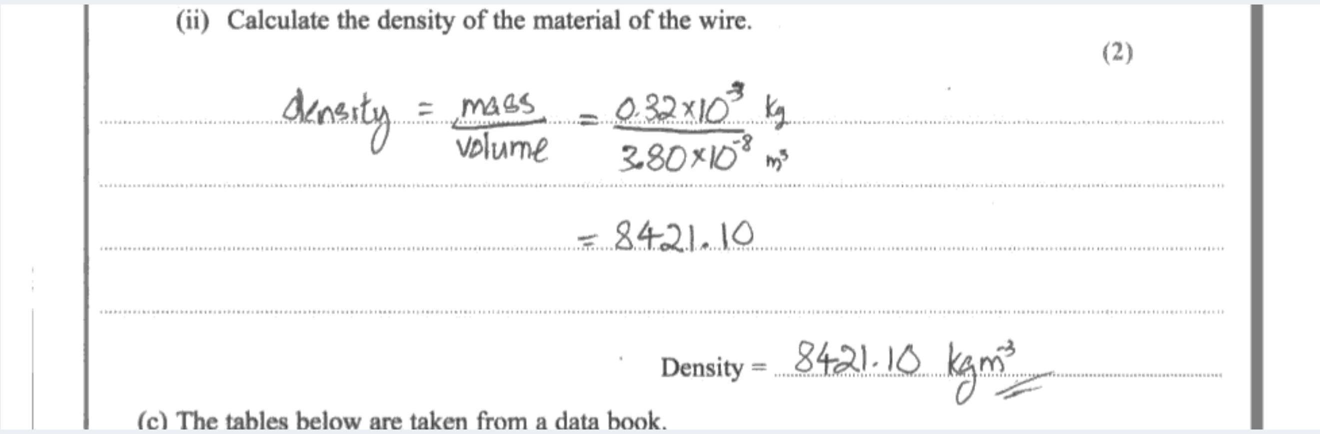
Question 1(b) (i)

This was an exercise in controlling powers of ten in a simple calculation and was done well.

Question 1(b) (ii)

One mark was for attempting the right calculation and the second was for getting correct result and with only 2 significant figures (SF). This is because the data in the question is almost all to 2 SF. This is in contrast to a later question.

Here is how to do the question



(ii) Calculate the density of the material of the wire.

(2)

density = $\frac{\text{mass}}{\text{volume}} = \frac{0.32 \times 10^{-3}\ \text{kg}}{3.80 \times 10^{-8}\ \text{m}^3}$

$= 8421.10$

Density = $8421.10\ \text{kg m}^{-3}$

(c) The tables below are taken from a data book.

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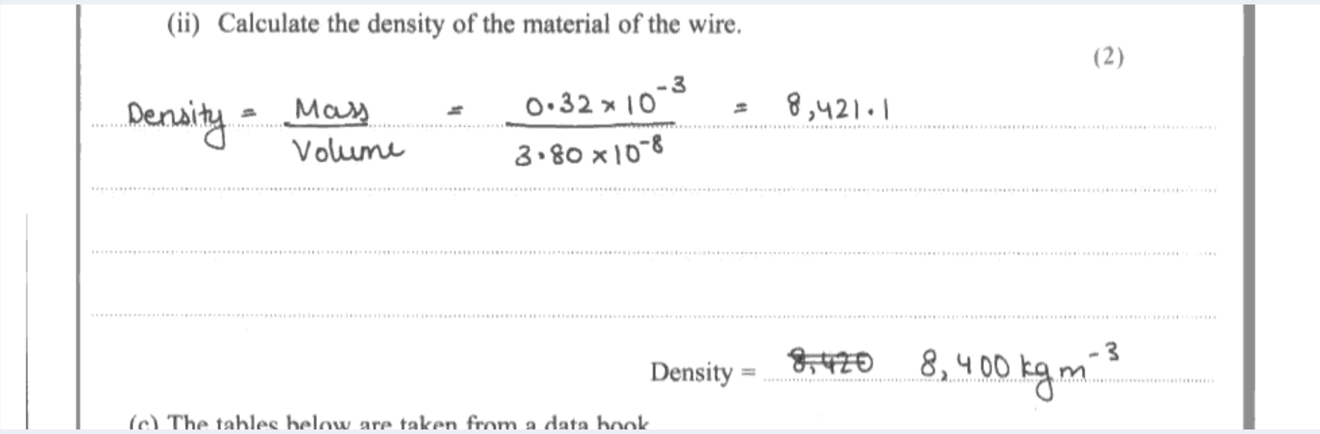
Examiner Comments

Perfectly fine, except that the answer suggests a precision that is just not there. The data is to 2 SF.



(ii) Calculate the density of the material of the wire.

(2)

Density = $\frac{\text{Mass}}{\text{Volume}}$ = $\frac{0.32 \times 10^{-3}}{3.80 \times 10^{-8}}$ = 8,421.1

Density = ~~8,420~~ 8,400 $kg\,m^{-3}$

(c) The tables below are taken from a data book

ResultsPlus

Examiner Comments

Here the candidate gets both marks for doing the same thing but quoting only 2 SF in the answer

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Examiner Tip

The number of SF in the answer depends on the precision of the data.

Question 1(c) (i)

The choice of Nichrome depended on getting the previous calculation right.

Question 1cii

The choice of 32 swg depended on getting the previous calculation right.

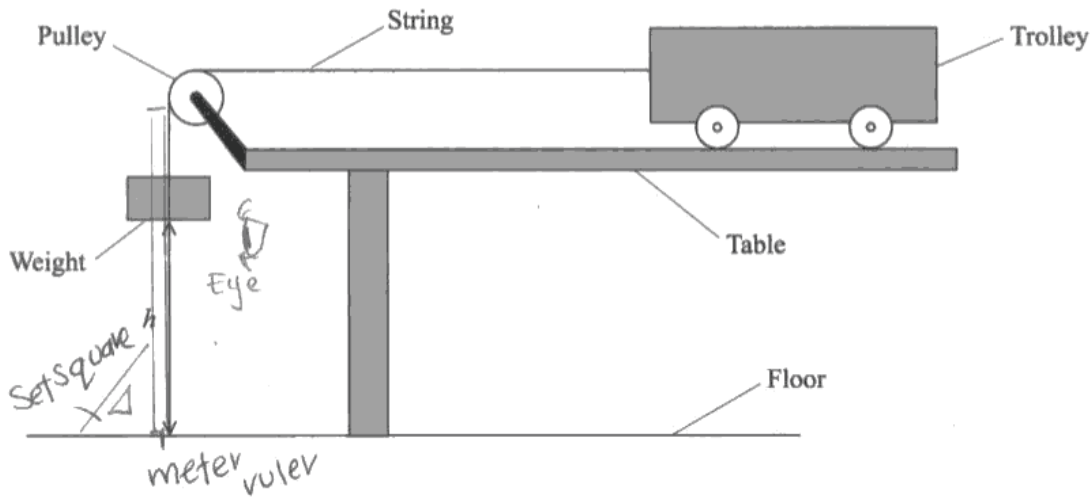
Question 2 (a)

Any technique for ensuring the measurement was accurate was accepted and was most often obtained from the diagram, it was much easier to answer the question by drawing as was suggested in the question.

The most common response was to show a rule with a set square to ensure that it was vertical.

This shows how it is a good idea to use a diagram

2 A student is investigating kinetic energy. He sets up the apparatus as shown.



The trolley starts from rest with the weight close to the pulley and at a height h above the floor.

(a) Describe how you would measure the height h. You may add to the diagram if you wish.

(1)

Measure h by placing a metre rule against the string vertically and use a set square to make it straight.

ResultsPlus Examiner Comments

The candidate has writen that the metre rule will be vertical, how do we know it will be vertical? Look at the diagram. In fact it is not worth writing anything, draw a good diagram. There is a bonus - the eye is shown looking across the bottom of the weight, this technique avoids parallax; it is not enough just to say 'avoid parallax' you have to say, or show, how you would do it.

ResultsPlus Examiner Tip

A good diagram is worth a lot of words. Examiners like diagrams.

Question 2 (b) (i-iii)

The first two questions deal with uncertainties. The first comes from the precision of the instrument, in this case the rule has a precision of 1 or 2 mm when measuring a length. In the second the uncertainty comes from the spread in the readings. In both cases a value with a unit is expected, many candidates gave the percentage uncertainty which was wrong. Many candidates thought the uncertainty in using a manual stopwatch was 0.5 s, this is probably too long and 0.1 s is more realistic, hence the spread of readings is more significant here.

The third part required a simple calculation but this time to 3 SF as the data here is to that precision.

This shows you about uncertainties first.

(b) The student records the distance h and the time t it takes for the weight to fall to the floor. His measurements are shown below.

h = 885 mm

t/s	2.94	2.76	3.28	3.15	3.02

The maximum velocity of the trolley is given by $\frac{2h}{t}$

(i) Estimate the uncertainty in the value for h. This should relate to your method in part (a).

(1)

Uncertainty = 1mm

(ii) Estimate the uncertainty in the readings for t.

(1)

Uncertainty = ½ × range = ½ (3.28 − 2.76) = 0.26
= 0.5 s

(iii) Calculate the mean maximum velocity.

(1)

Maximum velocity = $\frac{2h}{t}$ = $\frac{2 \times (885 \div 1000)}{[(2.94 + 2.76 + 3.28 + 3.15 + 3.02) \div 5]}$

= $\frac{2 \times 0.885}{3.03}$ = 0.584 ms⁻¹

Maximum velocity = 0.584 ms⁻¹

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Examiner Comments

(i) 1 or 2 mm is the uncertainty in a measurement made with a metre rule.
(ii) The candidate works out half the range, this would be correct. They then say it is 0.5 s, this is much to slow for a manual stopclock - so they lose the mark.
(iii) The candidate writes the equation, inserts the numbers, clearly showing how they fit. The SF in the answer match the data - here 3 SF - and the unit is correct too. Good exam technique.

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Examiner Tip

A single reading has an uncertainty that is the precision of the instrument; repeat readings give an uncertainty that is half the range.

(b) The student records the distance h and the time t it takes for the weight to fall to the floor. His measurements are shown below.

h = 885 mm

t/s	2.94	2.76	3.28	3.15	3.02

The maximum velocity of the trolley is given by $\frac{2h}{t}$

(i) Estimate the uncertainty in the value for h. This should relate to your method in part (a).

(1)

Uncertainty = 1 mm

(ii) Estimate the uncertainty in the readings for t.

(1)

Uncertainty = ½ (3.28 − 2.76)

~~= 0.26s~~ = 0.26 s

(iii) Calculate the mean maximum velocity.

(1)

Velocity = $\frac{2 \times 885 \times 10^{-3}}{3.03}$

= 0.58 ms^{-1}

Maximum velocity = 0.58 ms^{-1}

ResultsPlus
Examiner Comments

This candidate gains the mark for (ii) since they quote half the range of readings. They lose the mark for (iii) because they quote only 2 SF - the data is to 3 SF.

Question 2 (b) (iv-v)

(iv) asked candidates to perform a simple calculation but in the context of two separate masses. This was done well.

(v) asked for the uncertainties to be combined. Here the percentage uncertainties should be added and doubled as they are both in quantities that are squared. Very few candidates realised this.

The uncertainty and percentage uncertainty are different. Look at the whole clip to see how the question builds.

(b) The student records the distance h and the time t it takes for the weight to fall to the floor. His measurements are shown below.

h = 885 mm

t/s	2.94	2.76	3.28	3.15	3.02

The maximum velocity of the trolley is given by $\frac{2h}{t}$

(i) Estimate the uncertainty in the value for h. This should relate to your method in part (a). **(1)**

$\frac{1}{885} \times 100\%$

0.11%

(ii) Estimate the uncertainty in the readings for t. **(1)**

% uncertainty of t $= \frac{\frac{1}{2}(0.5)}{2.97} \times 100\%$ mean t = 2.97 s

$= 8.42\%$

(iii) Calculate the mean maximum velocity. **(1)**

Mean max^m velocity $= \frac{2 \times (885 \times 10^{-3})}{2.97}$ $\frac{m}{s}$

$= 0.60$

Maximum velocity = $0.60\ ms^{-1}$

(iv) The mass of the trolley is 0.930 kg and the falling weight has a mass of 0.030 kg. Calculate a value for the total maximum kinetic energy of the trolley and weight.

(1)

Maximum KE $= \frac{1}{2} \times (0.930 + 0.030) \times (0.60)^2$

$= 0.173$

Maximum kinetic energy = 0.173 J

(v) Estimate the percentage uncertainty in your calculated value for the kinetic energy.
Assume the uncertainty in the values of both masses is negligible.

(2)

% uncertainty of velocity = % uncertainty of h + % uncertainty of t

$= 0.11\% + 8.42\%$

$= 8.53\%$

∴ % uncertainty of K.E = 2 × % uncertainty of velocity

$= 2 \times 8.53\%$

Percentage uncertainty = 17.06 %

(Total for Question 2 = 7 marks)

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Examiner Comments

(i) The candidate is given credit here for using 1 mm, although the percentage they quote is not the right answer - but examiners cannot mark all wrong answers as correct so they lose the mark in (ii).
(iii) The candidate does not use the mean value of the time so loses this mark; but they use this velocity value correctly in (iv) and so get this mark.
In (v) the candidate uses the percentages worked out before, they add them and then double correctly since these terms are squared in the original equation.

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Examiner Tip

Read the question carefully to make sure you use the correct type of uncertainty.

Question 3 (a)

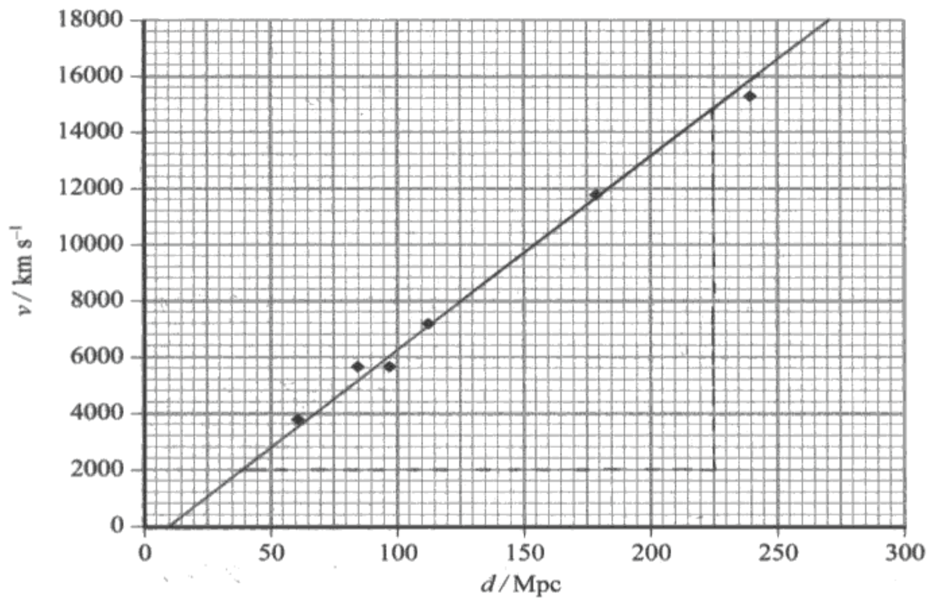
Many candidates did not realise that the wavelength of the light should be measured, giving a value for the red-shift, either term got the mark.

Although technically incorrect the answer 'Doppler shift' was given a mark.

Question 3 (b)

This was an easy Best Fit Line to draw and most candidates did it well. The gradient calculation did not need units but a large triangle was expected.

(b) The graph below is a plot of their data.



(i) Draw a line of best fit for this data. **(1)**

(ii) Determine the gradient of your line. **(2)**

$$\frac{14800 - 2000 \text{ kms}^{-1}}{225 - 40 \text{ Mpc}} = 69.2 \text{ kms}^{-1}\text{Mpc}^{-1}$$

Gradient = $69.2 \text{ kms}^{-1} \text{ Mpc}^{-1}$.

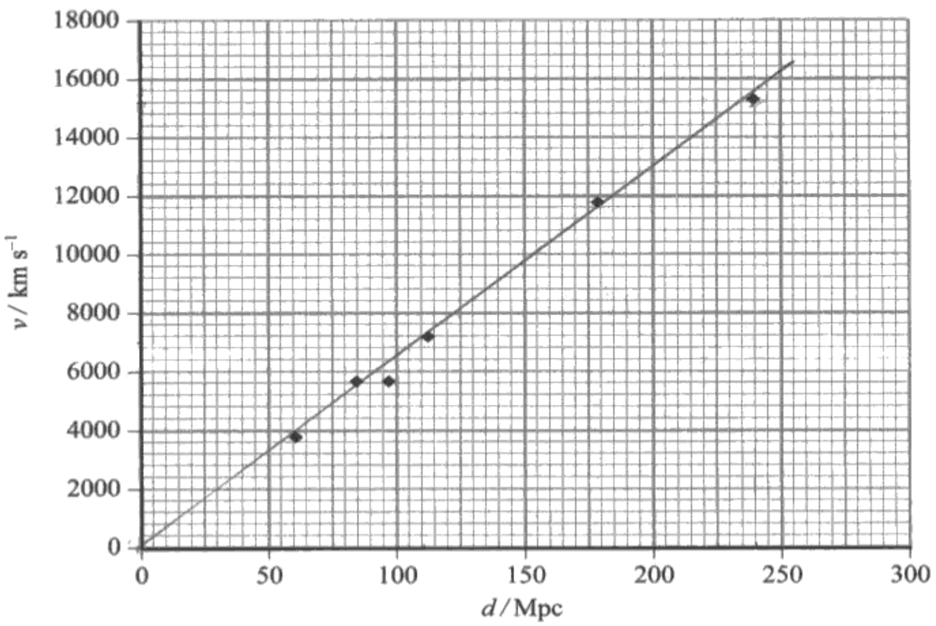
ResultsPlus Examiner Comments

It is not a bad BFL so gets the marks and the calculation is correct but the value is outside the tolerance of the answer. So 2/3.

ResultsPlus Examiner Tip

Your Best line should have points on both sides - this one here is 4 above and 2 below.

(b) The graph below is a plot of their data.



(i) Draw a line of best fit for this data. (1)

(ii) Determine the gradient of your line. (2)

$\frac{15500 - 6400}{240 - 110} = 70$

Gradient = 70

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Examiner Comments

The BFL is fine. The gradient triangle is too small (it should be at least 150 Mpc) and the points are read wrongly - the 110 should be 97 - and so the calculation is based on faulty data and must give the wrong answer.

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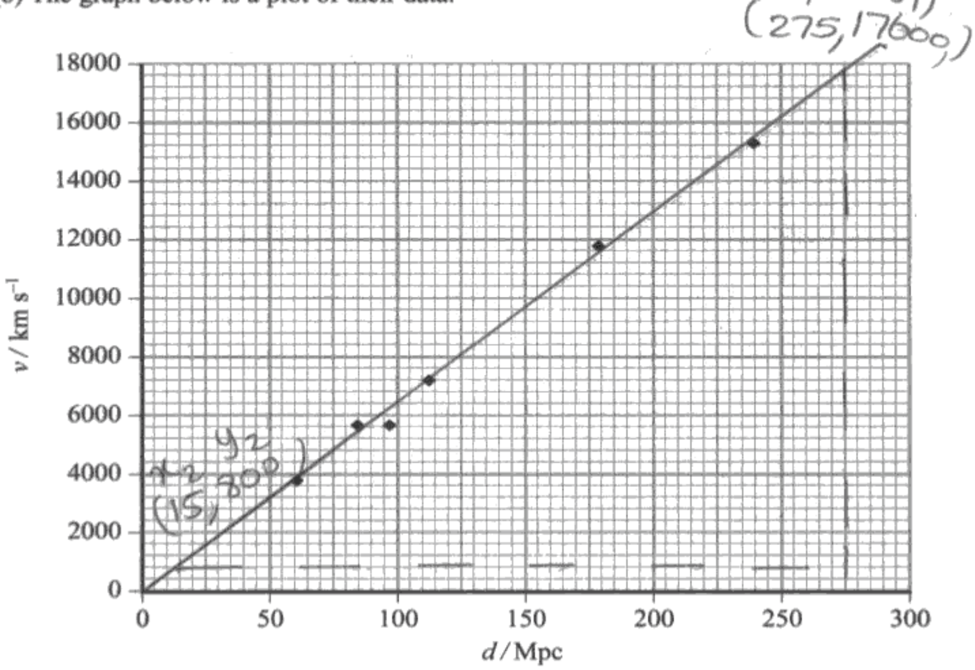
Examiner Tip

When reading data from graphs, check your readings as you do in an experiment

(b) The graph below is a plot of their data.



(i) Draw a line of best fit for this data. (1)

(ii) Determine the gradient of your line. (2)

$$\text{gradient} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{17{,}600 - 800}{275 - 15} = 64.62$$

Gradient = $64.6 \text{ km s}^{-1} \text{ Mpc}^{-1}$

ResultsPlus Examiner Comments

This is the best way to do it - draw the line to the edges of the grid and then write the values on the graph. Writing the coordinate values on the graph also helps.

ResultsPlus Examiner Tip

This is the way to do it.

Question 3 (c) (i)

Very many candidates did not write that for direct proportionality the line must be straight AND pass through the origin. A correctly drawn line did both in this question but many candidates did not say so and so lost the mark.

Question 3 (c) (ii)

A percentage difference uses the specified value (here 71) as the denominator. Only if there are two uncertain values should the mean be used - as in a percentage uncertainty calculation.

Question 4 (a-b)

This was the most testing part of the paper and required candidates to put their knowledge of radioactivity into a planning context.

a) The emphasis was in planning an experiment to produce a simple conclusion with some degree of certainty. Background radiation count was a vital part in this. Many candidates did not say they would use thick (bold) aluminium to stop the alpha and beta. Any amount of lead will do this.

b) This demanded greater organisation of knowledge and was done well by the stronger candidates, many scoring 4 or 5 out of 6 (there were 7 marking points). A number of candidates failed to address the question and scored poorly by concentrating on only one or two aspects of the experiment.

This is a good answer that contains a lot of good physics but the order means it needs a bit of careful reading.

4 *You are to plan an experiment to investigate the ability of gamma rays to penetrate lead. You are then to analyse a set of data from such an experiment.*

(a) You have a source of radiation and a detector and counter. Describe briefly a simple experiment to confirm that the source emits gamma radiation.

(3)

I would place the radiation source 20 cm away from the ~~de~~ detector (geiger moler tube). The detector /geiger moler tube would be connected to the counter. I would the place a ~~lead~~ block of lead blocking the path between the geiger moler tube and the radiation source (this is to cut out beta and alpha radiation) ~~the~~ ~~the counter~~ before this I would measure the backround radiation several times and take an average per minute. If the counter picks up a larger radiation count per minute then just ~~with~~ the backround radiation the source releases gamma radiation.

(b) You are provided with sheets of lead and apparatus to support them safely between the source and the detector.

The thickness of lead affects the count rate. Describe the measurements you would make to investigate this.

Your description should include:

- a variable you will control to make it a fair investigation
- how you will make your results as accurate as possible
- one safety precaution.

(6)

I would set up a gieger mular tube 20cm away from the radioactive source, this distance will remain at 20cm for the experiment as a control to make the test fair. sheets of lead consisting of 1cm width can be placed on at a time adding to the previous one. By taking the counts per minute up to a total width of 6cm the a table can be formulated/produced. multiple readings can be taken for each width of lead and a average taken to make sure the results are accurate as possible. Safety precaution could include not touching the radioactive source and keeping 10cm away from the source. background radiation could be minused from all the results.

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Examiner Comments

a) The candidate remembers to measure background and hence scores the third mark for recording a count above background.
b) This is a good answer although the safety mark is a little generous - 10 cm is not really enough for gamma radiation, but the candidate shows they have thought about safety in the right way. A diagram for one of the parts would have improved this overall but the language is clear enough.

Question 4 (c)

A comparison of the log equation with the equation for a straight line is expected. Candidates should be as explicit as possible.

(c) For gamma rays passing through lead of thickness x, the count rate A is given by

$$A = A_0 e^{-\mu x}$$

where A_0 is the count rate when there is no lead between source and detector, and μ is a constant.

Explain why a graph of ln A against x should be a straight line.

(1)

$\ln A = \ln A_0 + \ln e^{-\mu x}$ $\quad\quad$ $\ln A = \ln A_0 - \mu x$

$y = c + mx$

Since $\ln A$ against x is in the form $y = mx + c$ it is a straight line.

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Examiner Comments

It is clear that the candidate means to show which is the intercept and which the gradient.

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Examiner Tip

Lay out your answer so that your meaning is clear.

Question 4 (d)

This was a development of the graph skills tested in an earlier question. The logarithm of a quantity must have no units so in this question the graph axis is labelled ln (A/1/min). If the quantity was length measured in metres the log would become ln(x/m). This enables the gradient of the graph (the exponent) to have no units.

Scales should allow the plots to fill the paper and have no silly divisions (no 3's or 7's) so that interpolation is easy for gradient calculations. Plots should be crosses drawn with a thin pencil and not blobs and Best Fit Lines (BFL) should have points above and below.

This is an area in which very many candidates could improve.

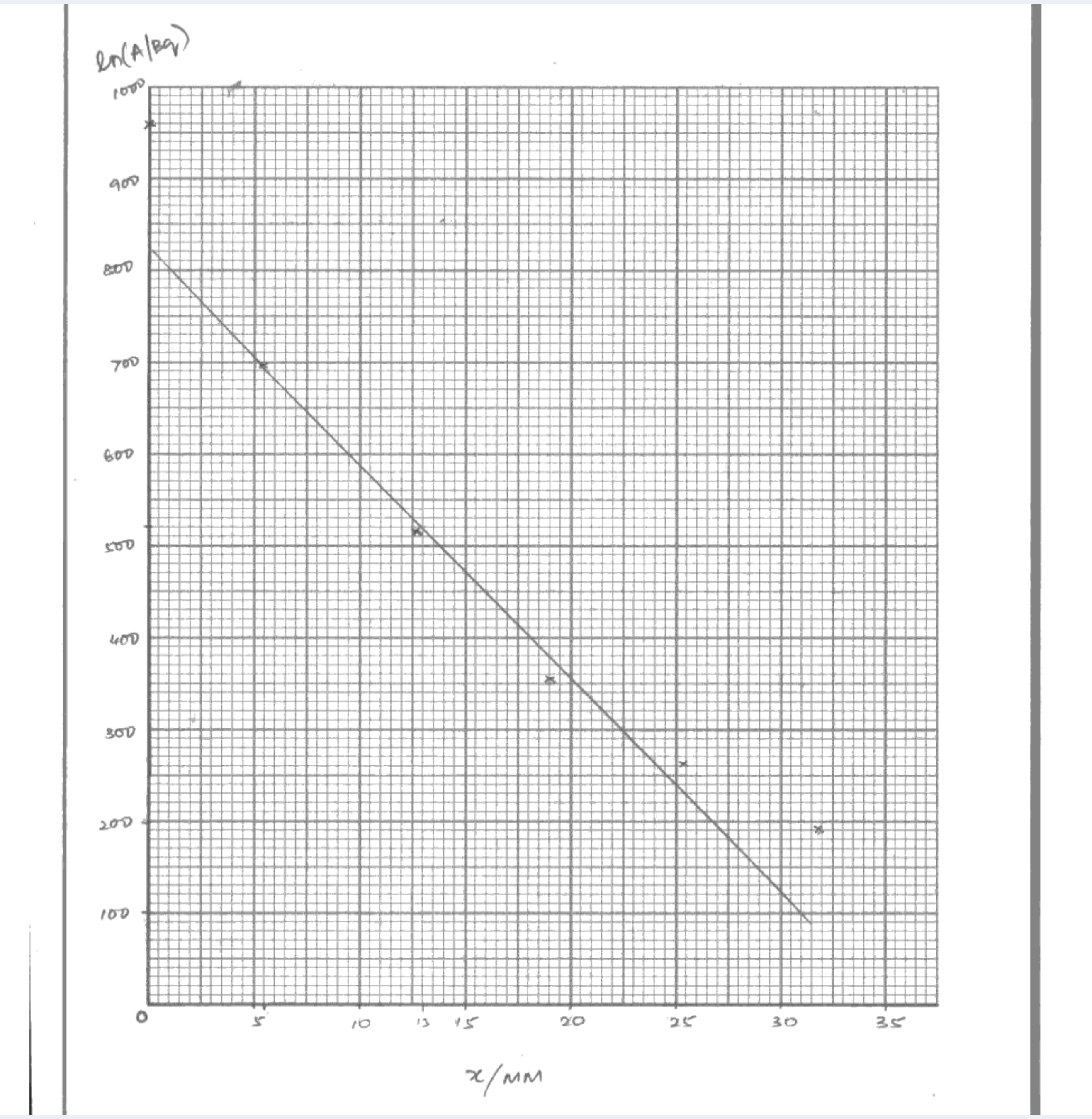
A crafty attempt but there are still marks awarded for the basic skills.

(d) The following data were obtained in such an investigation.

The background count was 40 minute^{-1}.

x / mm	Measured Count Rate / minute^{-1}	corrected count rate /min^{-1}	
0	1002	962	
6.30	739	699	
12.74	553	513	
19.04	394	354	
25.44	304	264	
31.74	232	192	

Use the column(s) provided for your processed data, and then plot a suitable graph on the grid opposite to show that these data are consistent with $A = A_0 e^{-\mu x}$.



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Examiner Comments

The candidate subtracts the background count but does not take logarithms.
The graph is labelled as a log graph but the corrected count rate is plotted. The 'straight' line does not fit the points which are a clear curve.

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Examiner Tip

It is always worth having a go even if you are not really sure what to do. Show what you can do.

A reasonable answer.

(d) The following data were obtained in such an investigation.

The background count was 40 minute^{-1}.

x / mm	Measured Count Rate / minute^{-1}	ln (A / minute^{-1})	
0	1002	~~6.96~~ 6.910	
6.30	739	~~6.605~~ 6.61	
12.74	553	6.32	
19.04	394	5.98	
25.44	304	5.72	
31.74	232	5.45	

Use the column(s) provided for your processed data, and then plot a suitable graph on the grid opposite to show that these data are consistent with $A = A_0 e^{-\mu x}$.

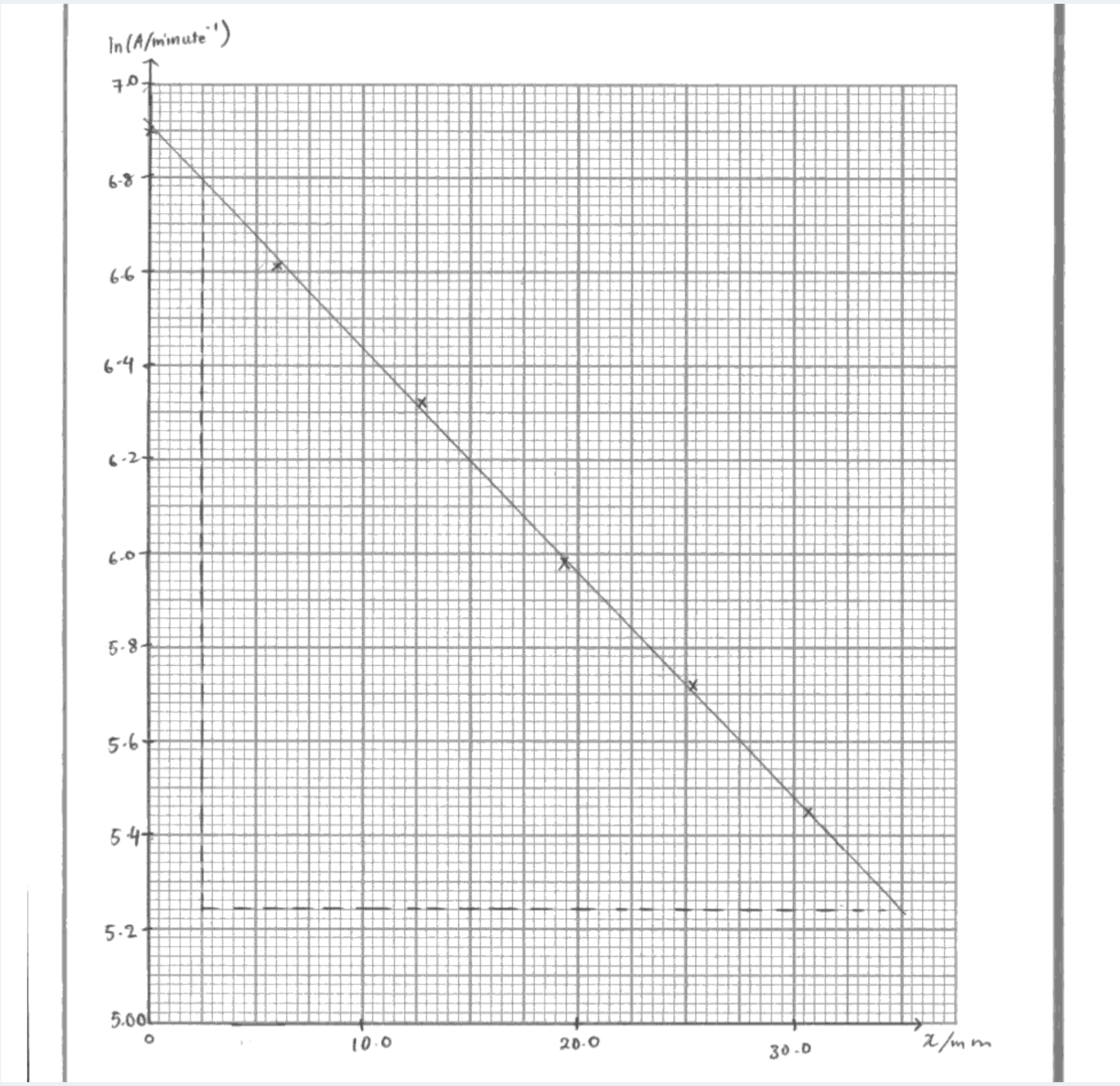
(5)

$A = A_0 e^{-\mu x}$

$\ln A = \ln A_0 + \ln e^{-\mu x}$

$\ln A = \ln A_0 - \mu x$

$\ln A = -\mu x + \ln A_0$.



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Examiner Comments

The candidate does not subtract the background count, but the unit is correct - this was unusual. The first plot on the graph is one whole square out and so they lose two marks.

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Examiner Tip

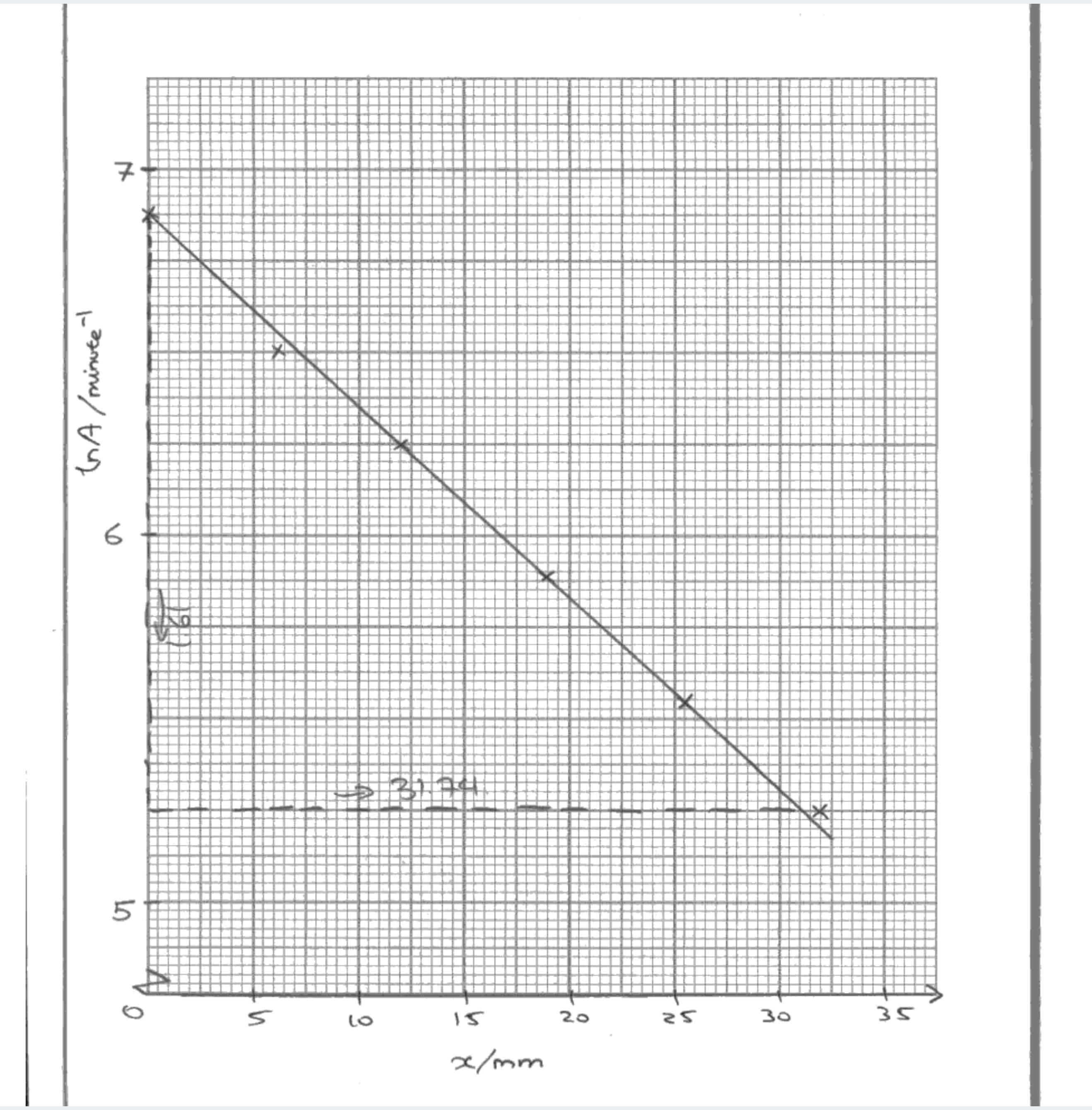
Graph plotting is a skill that requires a lot of practice and should be very accurate at this level.

Question 4 (e)

A large triangle was required again but almost no candidate got the unit of the gradient right. 3 SF is usually required to plot a graph and is the number of SF for a gradient.

This was a very poorly answered question.

What might appear as a good answer in fact scores zero.



(e) Use your graph to determine a value for the constant μ.

(2)

gradient = $-\mu = -0.05$, $\therefore$ $\mu = \underline{0.05}$.

μ = 0.05

(Total for Question 4 = 17 marks)

TOTAL FOR PAPER = 40 MARKS

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Examiner Comments

The gradient calculation is wrong. The graph shows the horizontal distance on the triangle to be 31.74, this is the x-value for the last point. The line does not pass through the point so the candidate is not calculating the slope of the line.

The candidate also omits the unit.

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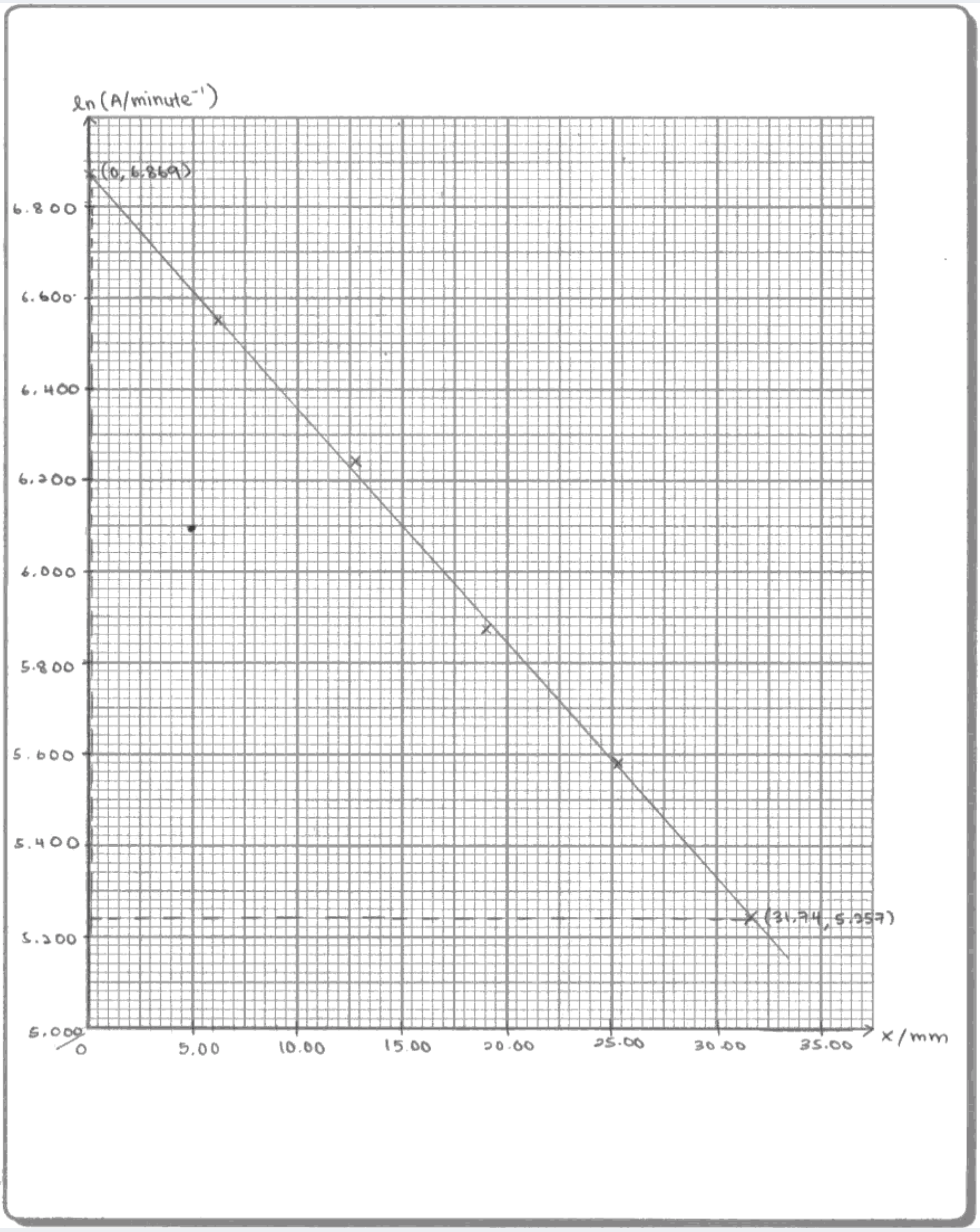
Examiner Tip

The best fit line is for taking a visual average. The gradient calculation must use coordinates from the line and not the points - unless they are squarely on the line.


ln (A/minute⁻¹)
(0, 6.869)
6.800
6.600
6.400
6.200
6.000
5.800
5.600
5.400
5.200
5.000
(31.74, 5.357)
0
5.00
10.00
15.00
20.00
25.00
30.00
35.00
x / mm

(e) Use your graph to determine a value for the constant μ.

(2)

$-\mu = m$

$m = \frac{\Delta y}{\Delta x} = \frac{6.869 - 5.257}{0 - 31.74}$

$= \frac{1.612}{-31.74} = -0.0508\ mm^{-1}$

$\mu = 0.0508\ mm^{-1}$

$\mu =$ 0.0508 mm^{-1}

(Total for Question 4 = 17 marks)

TOTAL FOR PAPER = 40 MARKS

ResultsPlus

Examiner Comments

A good graph and a clear calculation giving an answer in range with the correct unit.

Candidates who had done a variety of practical work scored higher marks on this paper. The practice they gain by carrying out measurements helps them appreciate uncertainty and precision so that they can tackle these questions which might well involve unfamiliar situations.

Questions will usually be set in the context of topics in the specification but there might also be pure data handling exercises.

Candidates showed good progression from AS but the marks that are not awarded are often due to the candidate not fully realising what is required.

Grade boundaries

Grade	Max. Mark	A*	A	B	C	D	E	N
Raw mark boundary	40	31	28	25	22	19	16	13

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