Examiners' Report
June 2017

IAL Physics 3 WPH03 01

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Introduction

This paper examines practical skills for overseas candidates. The best answers showed familiarity with practical investigations and apparatus and the need for the use of an appropriate number of significant figures in a paper testing practical skills. While most candidates realised that it is important to read the introduction to questions carefully and to address the tasks set, some penalised themselves, as in previous series, by not using scientific terms where appropriate or by quoting published mark schemes from previous years which were for different questions.

The mark scheme is published on the website and should be read with this report.

Section A

The majority of candidates answered the five multiple choice questions well, over 70% scoring 4 or more.

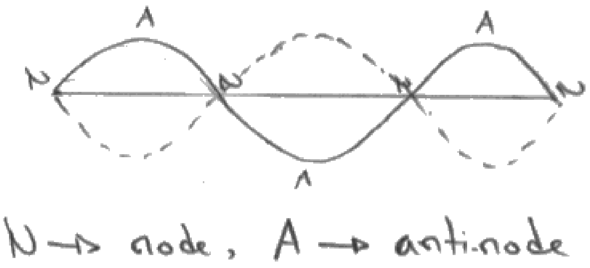
Question number and correct response	Topic	Most frequent incorrect response	Comment
1 C	SI system	A	There was confusion between units and quantities.
2 B	Finding a mean value	D	Most candidates understood the need to discard an anomalous result.
3 D	Viscosity	B	The relationship seemed well understood.
4 C	Selecting instruments	D	The appropriate instrument was well known.
5 B	Units	A	The unit could have been derived from the relationship.

Question 6 (a) (i)

Answers to this question were often disappointing: many simply restated the assertion given in the question. Also many of the diagrams drawn by students lacked the clarity afforded by basic labelling.

This is a good answer which gained both the available marks.

(2)



Burn ~~...~~ marks appear where intensity of microwaves is maximum, due to supperposition, i.e. at an anti-node(A). Distance between two successive burn marks is distance between two successive anti-node, ~~Dis~~ which is half of wavelength. Therefore, wavelength is twice the distance. ⇒ ~~Dist~~ Distance (d) = $\frac{\lambda}{2}$ ⇒ $\lambda = d \times 2$.

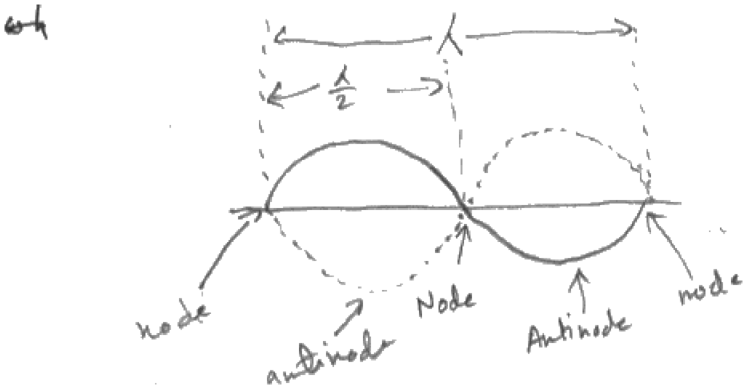
ResultsPlus
Examiner Comments

The diagram is clearly labelled.

ResultsPlus
Examiner Tip

Good diagrams are often a way to gain marks.

This was another good answer.



In standing waves, there are points called nodes, where energy is minimum, and antinodes, where energy is maximum. Burning occurs when there is an antinode (maximum heat energy). And, the distance between two adjacent antinodes is half the wavelength. That is why wavelength of microwave is twice the distance between the burn marks.

ResultsPlus
Examiner Comments

The link between the burn and maximum energy transfer at the antinodes is clearly explained.

ResultsPlus
Examiner Tip

Try to provide a reason for assertions.

Question 6 (a) (ii)

Many students scored full marks for the calculation and handled units, powers of 10 and significant figures effectively. The most common error was a mismatch of unit and value. Some students omitted the necessary doubling of the measurement given.

This is a good answer.

2450 MHz → Hz = 2450000000 Hz.

v = fλ   λ = ~~12 cm~~ 6 x 2 = 12cm / 100 = 0·12m.

2450000000 x 0·12m

v = 294 000000

2.94 x10⁸ ms⁻¹ = 3 x10⁸ ms⁻¹

Speed of microwaves = 2.94x10⁸ ms⁻¹

ResultsPlus
Examiner Comments

The conversion of unit submultiples is well done.

ResultsPlus
Examiner Tip

Remembering that the speed of microwaves should be the same as the speed of light is a useful way to check the answer.

Question 6 (b)

Most students were able to give a precision appropriate to their chosen instrument, although some did not give sufficient detail in their choice of instrument, for example saying 'ruler' rather than identifying the instrument properly as a metre rule, or as a 30 cm rule.

This answer gained full marks.

Metre Rule.

As it is a small distance of 6cm, it is easier to measure using a metre rule ~~been~~; because it ~~has~~ can ~~a~~ ~~precision~~ measure ~~of~~ to ~~± mm~~ the nearest ±1 mm

(ii) Calculate the percentage uncertainty in the 6.0 cm distance when measured with your chosen instrument.

(1)

Percentage uncertainty $= \frac{\pm 0.1}{6} \times 100\%$

$= \pm 1.666$

$\approx 1.67\%$

Percentage uncertainty = ± 1.67 %

ResultsPlus

Examiner Comments

The choice of a metre rule is clearly justified.

ResultsPlus

Examiner Tip

Remember to use a sensible number of significant figures.

A vernier caliper is also a suitable instrument for the required distance.

(2)

A vernier ~~calibre~~ calliper would be suitable as it measures distance to the nearest 0.1 mm.

~~The percentage error would be 1.667.~~

(ii) Calculate the percentage uncertainty in the 6.0 cm distance when measured with your chosen instrument.

(1)

$\frac{0.1\,mm}{60\,mm} \times 100\% = 0.167\%$

Percentage uncertainty = 0.167%

ResultsPlus

Examiner Comments

This answer gained full marks.

ResultsPlus

Examiner Tip

Learn how to calculate percentage uncertainties.

Question 7

There were very mixed responses to this question; good answers appreciated that a lamp does not obey Ohm's Law and will get hot.

(a) Students usually drew good circuit diagrams, often using an acceptable mix of conventional circuit symbols and suitable labels. Very few of the circuits seen would not work and nearly all included some appropriate means to vary the lamp current.

(b) Nearly all of the students successfully identified the required quantities and instruments. A few suggested measuring resistance directly with an ohmmeter, which would be an inappropriate technique for this experiment.

(c) Some students gave a response that was perhaps more appropriate to questions seen in some previous papers. They stated that heating (of the lamp) would be an issue and recommended avoiding repetition as a consequence. Those students who did recommend repetition and gave a specific valid aim, for instance to obtain a mean, gained the mark.

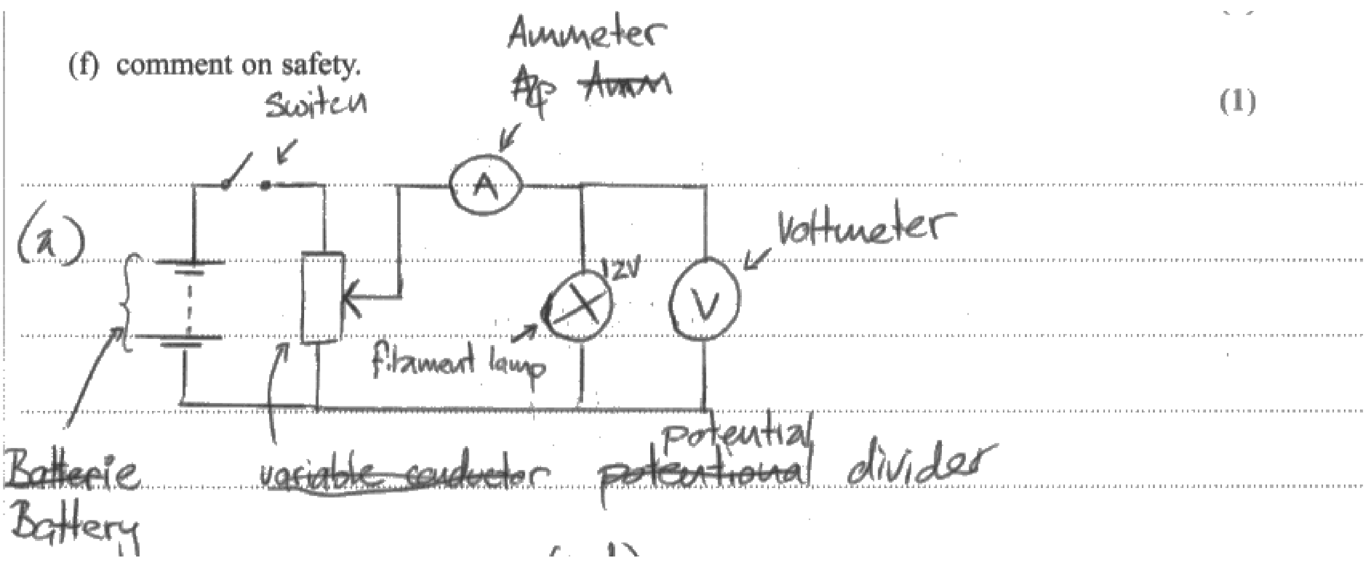
(d) Most students sketched a V-I graph, but many drew the curve incorrectly or showed a straight line. Few students gave an explanation that included the calculation of resistance directly from R=V/I. Many went on to suggest using the gradient of their graph to find resistance, which is an inappropriate technique for this experiment.

A small proportion of students suggested calculating resistances directly from R=V/I and then drawing a V-R graph. This approach generally led to a better score for this part of the question.

(e) Most students identified a source of uncertainty or systematic error and usually mentioned zero error on a meter. Fewer linked possible parallax error to the use of the scale of an analogue meter.

(f) Many students commented that the experiment was low risk due to the low potential differences expected. Many realised that it would be sensible to avoid touching the lamp whilst it was hot.

Although this is a good answer, the candidate did not realise that a lamp must heat up to produce light.



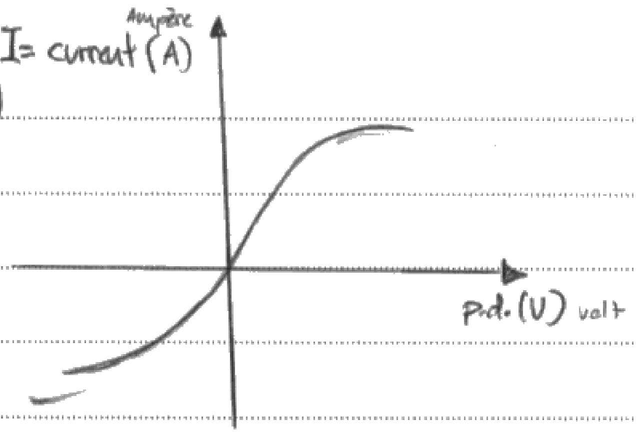
(b.) curren(I) and potential difference (V) has to be measured. Current ~~is~~ will be measured with Ammeter and potential difference (p.d.) with Voltmeter

(c.) ~~yes, repeat readins is required to calcolate the gardient.~~

No, Battery and lamp can blew because of high voltage and high temperatore.

(~~wait~~ have to wait 5min before we ~~z~~ take the next readings ~~+~~ give time to cool down for the heatet up material)

(d.)



~~resit~~ resistance = ~~Vo~~ Potential difference / current = $R = \frac{V}{I}$

~~When~~ Tempurature increase

~~Because of heating~~ ~~increase of temperature~~ after a certain amount of p.d. & so the resistance also increase. The values of resistance will be not consistance, difficultie in take mesurments.

(e.) reding values from the Ammetere. human error ~~while~~ because of incorrect reading or Ammeter dosent show correct value. Zero error with ~~Volt~~ Voltmeter and Ammeter.

(f.) use of low voltage (p.d) to ~~p~~ prevent electro shocks and wearing gloves to prevent burning hands. ~~Ca~~ ~~te~~ Wire and lamp will be heatet up.

ResultsPlus
Examiner Comments

The candidate scores full marks for parts (a), (b), (d) and (f).

In (c) the candidate is not awarded a mark as the point that repeat readings can be used to determine a mean or identify errors has been missed.
'Human error' is not a comment which gains a mark, so the second mark is not awarded for part (e).
In (f) the candidate has realised that the low p.d. used means that this is an experiment with a low risk.

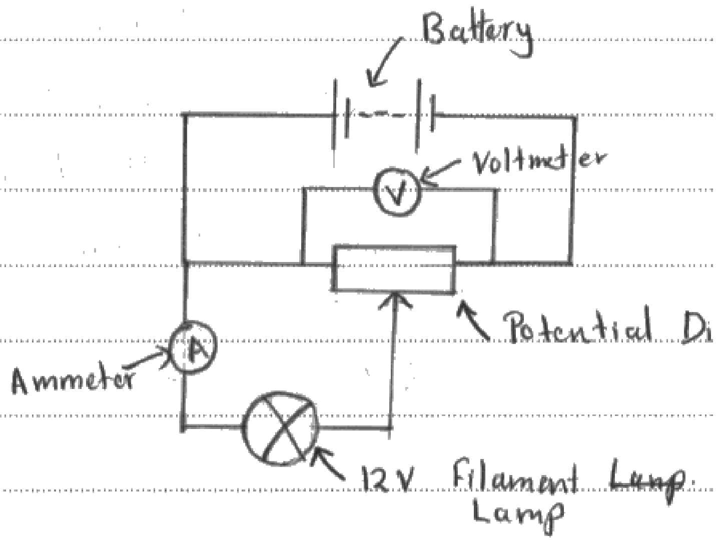
ResultsPlus
Examiner Tip

Gloves are not generally necessary in experiments of this type.

This answer has some weaknesses but answers are clearly explained.

7)

a)



b) Voltage should ~~me~~ be measured. A voltmeter should be used to measure it with least count ~~a~~ in mV. It should have a range of 0 V to 24 V. Voltmeter reading should be measured in V.

~~A~~ Current ~~SI~~ should be measured. For measuring current, A Ammeter is used. It should have a least count in ~~p~~ mA. Ammeter reading should be able to read in mA.

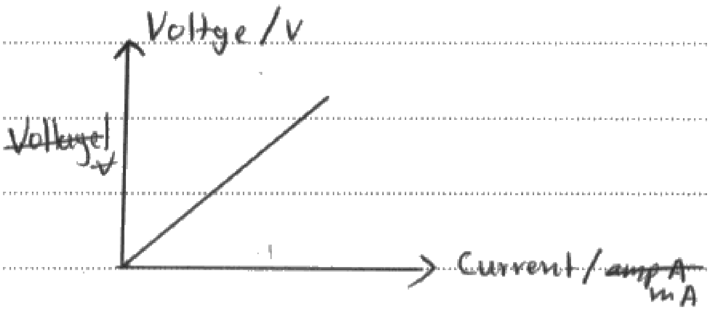
c) ~~P~~ Yes, repeat readings are need to get an ~~mean~~ avarage value. Any anamalous readings can ~~be iden~~ then be identified. A each particular voltage, an avarge current should be calculated.

d) $V = IR$

$V = R \times I$

$\Downarrow \quad \Downarrow \quad \Downarrow$

~~m~~ $y = m x$ ~~x~~



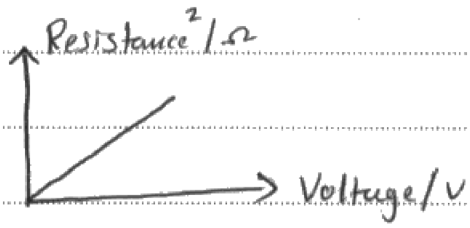
The aquired results are put in a table as such;

Voltage/V	Current/mA
✓	x
✓	x
✓	x
✓	x
✓	x
✓	x

Then for each voltage, the resistance is calculated by susbstituting for the equation

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

Then a graph is drawn,



Finally, for any potential difference, the resistance could be obtained.

e) Zero error in the instrumets, voltmeter and Ammeter. Systematic Error.

Paralax error when reading the voltmeter reading and Ammeter reading if Ananolgue instruments are used.

~~The student~~

f) The ~~*~~ fillament bulb is hot so can burn ~~sit~~ skin.
Avoid contact with the bulb.
The is a chance of getting electrical shocks so wear rubber gloves and shoes.
The fillament bulb could explode due to high voltages so ~~wer~~ wear goggles.

ResultsPlus
Examiner Comments

The voltmeter is incorrectly positioned so a second mark is not awarded in part (a)
In part (d) the graph has been sketched as a straight line rather than a curve, so only two marks are awarded.
All the other marks have been awarded.

ResultsPlus
Examiner Tip

Remember to specify the type of meter as analogue if suggesting parallax errors .

Question 8 (a)

Most students pointed out the inconsistency in the choice of significant figures for recording values in the table. Some appeared to show confusion between the precision of a measurement and the number of significant figures used to record it.

Many observed that the results did not show any evidence of repetition or readings on unloading. Fewer mentioned that it would be useful to take some additional measurements between 600 g and 1000 g.

This is a good answer.

(a) Criticise his results.

(3)

- The force column and extension column, is inconsistent with the significant figures after ~~and~~ decimal point.
- No evidence for repeat readings
- Only six sets of readings, ~~show~~ there should be more readings between 600 g and 1000 g.

ResultsPlus

Examiner Comments

The answer clearly points out the need for extra readings in a specified range.

ResultsPlus

Examiner Tip

Use bullet points as this answer does to make answers concise.

This is another good answer.

Extension (Δx) values are recorded to inconsistant significant figures
Not enough readings ~~taken~~ of taken between 600g and 1000g ~~as there~~
~~Only 6~~ No repeat measurements taken to calculate a mean
Force values are recorded to inconsistant significant figures

ResultsPlus
Examiner Comments

Extension and force are both clearly identified as having inconsistent significant figures.

ResultsPlus
Examiner Tip

It is a good idea to link taking repeat measurements with the calculation of a mean.

Question 8 (b)

Some students concentrated on their reasons for choosing a particular measuring instrument, rather than giving a description of how they should measure the diameter of the wire. Many responses included the techniques of repeating and averaging, fewer made reference to the need to measure the diameter at different positions or at various orientations along the wire.

This is a good answer.

The diameter of the wire should be measured using a micrometer and should be repeated more than once for an average to be taken. It should be repeated at more than one place on the wire since there might be kinks on the wire.

ResultsPlus

Examiner Comments

Calculation of the mean is linked to the need for multiple readings.

ResultsPlus

Examiner Tip

Remember to justify statements where possible.

This is another good answer.

(b) Describe how the student should measure the diameter of the wire.

(2)

- He should use a micrometer screw gauge and get the diameter across the wire, round the wire at different points of the wire and then get the average of all the diameters.

ResultsPlus
Examiner Comments

Rotating the instrument is mentioned.

ResultsPlus
Examiner Tip

Remember that the measurement of diameter of a wire should be taken at different orientations.

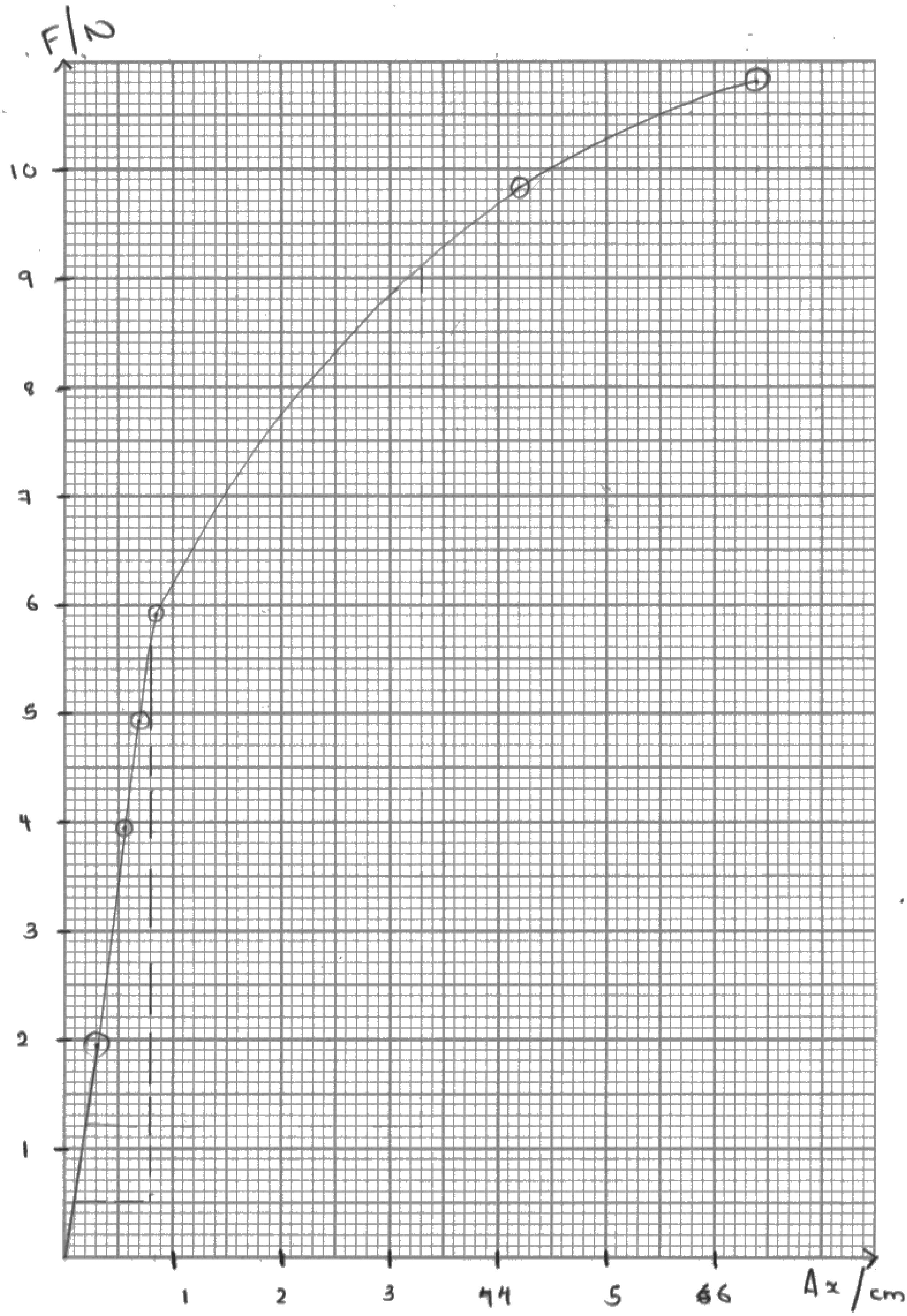
Question 8 (c)

(c) (i) Students generally showed good skill in drawing the graph. Nearly all presented properly labelled axes with appropriate scales. Plotting was accurate in most cases, but many students found it difficult to drawing a line of best fit, either the line did not extend towards the origin or wavered in the curved part.

(c) (ii) Some comments on the shape of the graph were clear, accurate and concise. However, many students avoided commenting on both the types of behaviour exhibited and concentrated solely on the line through the first four points.

(c) (iii) There were some excellent successful calculations, but many students struggled here. It is important that working is shown clearly, so that the examiners can reward the worthwhile points made during an unsuccessful attempt. Some students omitted to halve the value of the diameter of the wire when substituting radius into the formula for cross sectional area. Some students chose to substitute values (or a gradient) from the curved part of their graph and obtained a Young modulus value that was outside the acceptable range. Students should remember that it is important to present their answer with an appropriate number of significant figures and the correct unit.

This is a good graph with a carefully drawn curve.



ResultsPlus
Examiner Comments

All marks have been awarded as a sensible scale is shown, the axes are labelled with units and the points are clearly defined.

ResultsPlus
Examiner Tip

It is a useful to have a pencil with a sharp point to draw lines on graphs and diagrams.

This is a good answer to parts ii and iii.

The graph shows a positive correlation between force applied and extension of the wire. There is a linear relationship up to the limit of proportionality after that the graph curves, and smaller increase in force gives larger increase in extension after the yield point.

(iii) Use your graph to determine the Young modulus of the material the wire is made from.

(4)

$E = \frac{F}{A} \div \frac{\Delta x}{x}$

$E = \frac{F}{A} \times \frac{x}{\Delta x}$

$EA\,\Delta x = F \times x$

$\frac{EA\,\Delta x}{x} = F$

$F = \frac{EA}{x} \times \Delta x$

↑ y, ↑ m, ↑ x

$m = \frac{EA}{x}$ where E = Young Modulus, A = Cross sectional area, x = original length

$701.43 = \frac{E \times [\pi \times (1.225 \times 10^{-4})^2]}{1.35}$

$E = 2.01 \times 10^{10}$ Pa

Young modulus = 2.01×10^{10} Pa

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Examiner Comments

In part (ii) a mark would not have been given for the phrase ‘positive correlation’ alone, however the candidate also said that there was a linear relationship.
The answer to part (iii) has been carefully set out and all stages of the calculation are clearly shown.

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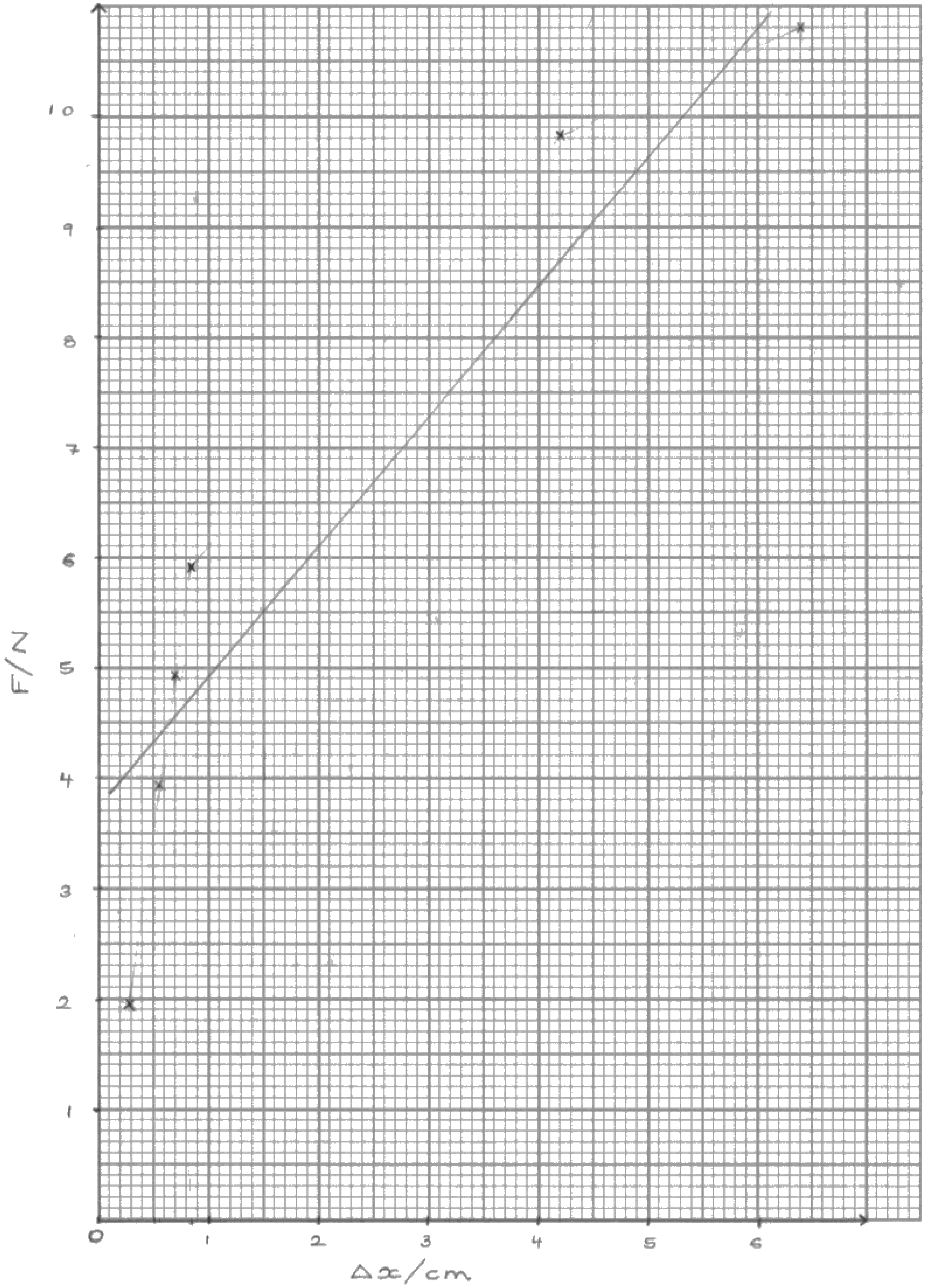
Examiner Tip

Set out your working clearly.

Although the points are plotted correctly, the candidate has drawn a straight line rather than a curve.



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Examiner Comments

A good choice of scales and carefully plotted points but the candidate has not realised that the line is a curve not a straight line and so has lost the mark for the line of best fit.

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Examiner Tip

Remember that lines of best fit are not always straight lines.

Paper Summary

Most candidates tackled the questions confidently and it was pleasing to see that some had a good understanding of practical experiments, techniques and skills.

Based on their performance on this paper, candidates are offered the following advice:

- Read the question carefully.
- Learn the SI base quantities and corresponding units.
- Make sure you have a pencil with a sharp point and a ruler.
- Draw circuit diagrams using accepted symbols for electrical components.
- Use multiples or sub-multiples of 1, 2 or 5 for scales on a graph.
- A line of best fit can be a curve.
- Don't force a straight line on a graph through the origin.
- Remember to justify assertions.

Grade Boundaries

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