Examiners' Report
June 2016

IAL Physics 3 WPH03 01

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Introduction

This paper examines practical skills for overseas candidates. Some of the criteria are derived from the criteria which have been used for coursework for home centres.

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

Q 1-5

The multiple-choice questions were generally answered well, although questions 2 and 3 had lower mean marks.

Question 6

Question 6(a) was straightforward for most students. Most identified the limits of the range; a few chose simply to state its magnitude.

Question 6(b) enabled most students to show sound technique when calculating the percentage uncertainty. Fewer could express their result using an appropriate number of significant figures.

Many responses to question 6(c) included an appropriate improvement to the method, but omitted proper comment as to why it was necessary. Students who mentioned uncertainty tended to refer back to the stated uncertainty in the reaction time itself, rather than focusing on reaction time as the cause of an unacceptably high percentage uncertainty in the 3 s time measurement. Few calculated this percentage uncertainty caused by reaction time, but most did suggest a suitable alternative technique.

6 A student's uncertainty in recording her reaction time was ± 0.03 s.
She recorded a reaction time of 0.38 s.

(a) What was the range of her measurements?

(1)

Her range was from 0.35s to 0.41s.

(b) Calculate the percentage uncertainty in her measurement.

(2)

$\frac{0.03}{0.38} \times 100$

$= 7.9\%$

Percentage uncertainty = 7.9 %

(c) The student plans to use a stopwatch to measure the time taken for a trolley to move down a slope. She estimates this time to be about 3 s.
Comment on her plan.

(2)

Her plan is not accurate or reliable due to the time being too short, so the human reaction time will have a significant effect on the readings she took with the stopwatch. $\frac{0.38}{3.00} \times 100 = 13\%$, her uncertainty will be 13% which is high. A longer distance should be used for the slope or light gates could be used instead of the stopwatch to eliminate human reaction time.

(Total for Question 6 = 5 marks)

ResultsPlus
Examiner Comments

This is a good answer which gained full marks.

ResultsPlus
Examiner Tip

The candidate could use bullet points to confine the answer to the space provided. The number of lines provided is a good guide to the length of the answer required.

Question 7

Most of the plans were laid out clearly and showed familiarity with the necessary techniques. A few students offered a prepared response that addressed the requirements of a different experiment.

In their response to part (a), most students showed or listed all the apparatus, although some omitted to include a suitable light source. A few students struggled to name the protractor correctly.

The diagram usually showed the correct angles labeled for part (b). Nearly all students included a correctly drawn normal.

There was some evidence in responses to part (c) of confusion over the precision of a protractor. Many students gave this precision incorrectly as ±0.1°.

The markings on a protractor are often about 1 mm apart and several students appeared to interpret this as a curved millimeter scale, giving the precision as ±1 mm.

Most students realized that it would be sensible to repeat the readings. Fewer included a comment in their response to part (d) as to why this would be appropriate.

Most students gave excellent responses to part (e), explaining clearly how they would use the data to draw a graph and determine the refractive index. Some simply quoted the refractive index relationship from the data pages, without explaining how they would use it.

Very few students identified an acceptable main source of systematic error in their response to part (f).

Relatively few students could give acceptable comments on safety in their response to part (g). Many answers included inappropriate precautions against broken glass or falling weights.

7 A student is asked to determine the refractive index of glass.

Write a plan for this experiment that uses a rectangular glass block, standard laboratory apparatus and a graphical method.

You should:

(a) draw a labelled diagram of the apparatus to be used and list any additional apparatus needed,

(2)

(b) show on your diagram the quantities to be measured,

(2)

(c) explain your choice of measuring instrument for **one** of these quantities,

(2)

(d) comment on whether repeat readings are appropriate in this case,

(1)

(e) explain how to determine the refractive index,

(3)

(f) identify the main source of uncertainty and/or systematic error,

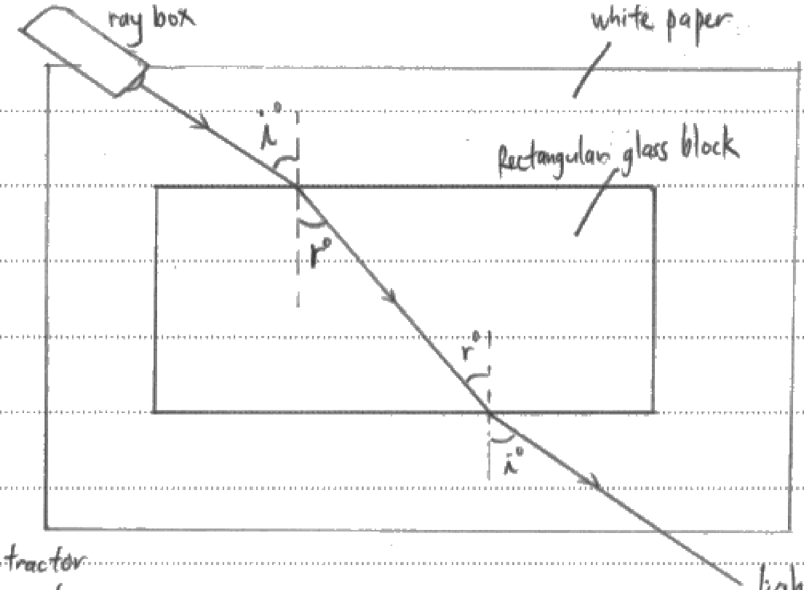
(1)

(g) comment on safety.

(1)

This was a good answer.

a), b)



~~Proctractor~~ Protractor to measure angle.

~~i° = angle of~~ i° and r° to be measured where i° = angle of incidence and

r° = angle of refraction

c) ~~Proctra~~ Protractor can measure to a precision 1° and ~~is~~ has adequate range of angle which is 1° – ~~90~~ 180° for this experiment.

d) Repeat readings ~~is~~ are appropriate to get a more accurate results.

e) Record results for i° and r°.

Calculate sin i° and sin r°

Plot a graph of sin i° against sin r° and draw a line of best fit.

Calculate the gradient of the graph where the gradient of the graph is the refractive index.

f) Parallax error may occur when taking the reading on the protractor

g) We ~~Wear goggles, the light ray from the ray box may hurt our eye~~
Low risk as no high voltage or heavy object that may cause injury.

ResultsPlus
Examiner Comments

The emergent angle is correctly marked as equal to the angle of incidence.

In (d) the candidate did not say that the reading would be averaged and therefore was not awarded the mark.

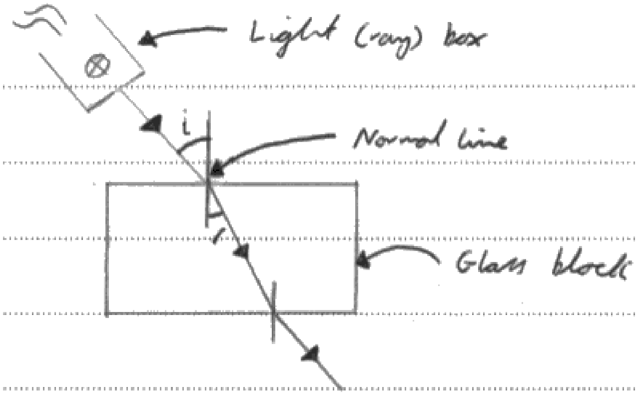
The candidate did not get the mark for (f) as protractors are made with markings on the base to prevent parallax error. This was not widely understood.

ResultsPlus
Examiner Tip

A sketch of the graph to be drawn would be a good addtion in part (e).

Another good answer.

a)



A ruler, pencil, protractor and power supply will also be needed. A Sheet of paper ~~sorry~~ may be placed under the glass block to trace the rays of light.

b) 'i' is the angle of ~~[illegible]~~ ~~[illegible]~~ incidence which should be measured between the normal and the ray of light entering the block. 'r' is the angle of refraction and should be measured between the normal and the refracted light ray.

c) A protractor should be used to measure the angle of incidence as it allows a large angle (up to 180° depending on the protractor) to be measured with a precision of 1°.

d) Yes, repeat readings may be taken to form an average and increase reliability. This is because none of the components are affected in a way that could alter the results by being left on for prolonged ~~[illegible]~~ periods of time.

e) ~~Multi~~ Multiple readings should be taken by moving the light box which will vary the angle of incidence and allow the corresponding angles of refraction to be taken. A table of the ~~sine~~ sine of i and the sine of r should be drawn up. A graph of ~~sin~~ sin (i) on the y-axis against sin (r) on the x-axis should be plotted where the gradient will be equal to the refractive index of the glass.

f) The main source of uncertainty will come from the measurements ~~of~~ of the angles i and r due to the ~~possibility~~ possibility of parallax error. Readings ~~should~~ should be taken at eye level to avoid this.

g) This experiment poses a low risk as the potential difference of the power supply is quite low. Students should not touch the light box as it will ~~heat~~ heat up during longer periods of use.

ResultsPlus

Examiner Comments

This candidate has said that repeat readings would be averaged.

ResultsPlus

Examiner Tip

Remember to use a ruler for diagrams, like this candidate.

Question 8 (a)

Most students correctly identified a micrometer as an appropriate instrument for measuring the diameter of the wire and gained a mark for part (a). Fewer went on to point out that the measurement should be repeated in such a way as to take account of irregularities in the shape or thickness of the wire.

A good answer.

8 In an experiment to determine the resistivity of the material of a wire, a student measured the diameter of the wire to be 0.56×10^{-3} m.

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

(2)

The student should measure the diameter of the wire at different places ~~&~~ of the wire, record the diameters and then take avereage.

ResultsPlus
Examiner Comments

This gained both marks.

ResultsPlus
Examiner Tip

It is important to identify good measurement techniques.

Another good answer.

8 In an experiment to determine the resistivity of the material of a wire, a student measured the diameter of the wire to be 0.56×10^{-3} m.

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

(2)

The diameter should be measured using a micrometer screw gauge with a precision of 0.01 mm to ~~increase~~ insure accuracy. The diameter can be measured at different points of the wire and while rotating it as well after which the mean of the diameter readings should be noted.

ResultsPlus
Examiner Comments

This answer also mentions rotating the micrometer.

ResultsPlus
Examiner Tip

It is always good practice to justify assertions.

Question 8 (b) (i)

Nearly all the students were able to criticise the table of results appropriately. A few students omitted to target their comment about inconsistent precision to the relevant column of data.

A good answer.

(b) During this experiment, the student kept the current constant at 0.11 A and recorded the following results.

Length / m	Potential difference / V	Resistance / Ω
1.00	0.52	4.72
0.80	0.41	3.72
0.60	0.27	2.45
0.40	0.19	1.72
0.20	0.1	0.90

(i) Criticise his results.

(2)

A small number of readings have been taken. No repeats or averages can be seen. There is also a slight inconsistency in precision of the last value of potential difference (the signifigant figures not the same).

ResultsPlus
Examiner Comments

The comment about inconsistent figues is clearly related to a value in the table.

ResultsPlus
Examiner Tip

In a question about practical experiments use of the appropriate number significant figures is essential.

This answer displays unfamiliarity with practical situations.

(b) During this experiment, the student kept the current constant at 0.11 A and recorded the following results.

Length / m	Potential difference / V	Resistance / Ω
1.00	0.52	4.73
0.80	0.41	3.73
0.60	0.27	2.45
0.40	0.19	1.73
0.20	0.1	0.91

(i) Criticise his results.

(2)

The gaps between the length values recorded is big and the gap between the voltage values is not equall.

ResultsPlus
Examiner Comments

0.20 m is an acceptable increase in length.

ResultsPlus
Examiner Tip

Remember that in an experiment the dependant variable does not always increase in equal steps.

Question 8 (b) (ii)

Although many students gave an appropriate suggestion as to how the current should be kept constant, a significant number gave incorrect responses.

This is an example of a poor response.

(ii) Suggest how the student could keep the current constant. (1)

By using a fixed resistor.

ResultsPlus
Examiner Comments

A fixed resistor would not work!

ResultsPlus
Examiner Tip

Consider carefully what any circuit component is intended to do.

This is a good answer.

(ii) Suggest how the student could keep the current constant. (1)

By using a fixed resistor.

ResultsPlus
Examiner Comments

The candidate has named a standard circuit component.

ResultsPlus
Examiner Tip

Justifying an answer is good practice.

Question 8 (b) (iii) - (c) (iii)

Nearly all students drew a good graph for part (c)(i). The most common fault seen was an unbalanced line of best fit. Some students overlooked the examiner's expectation of a suitable scale (with intervals of 1, 2 or 5) and produced a scale with 3 cm intervals.

Most responses to part (c)(ii) showed skilful calculations of gradient. Some students constructed a small triangle that made use of less than half of their drawn line. Careless use of significant figures was evident in a few cases.

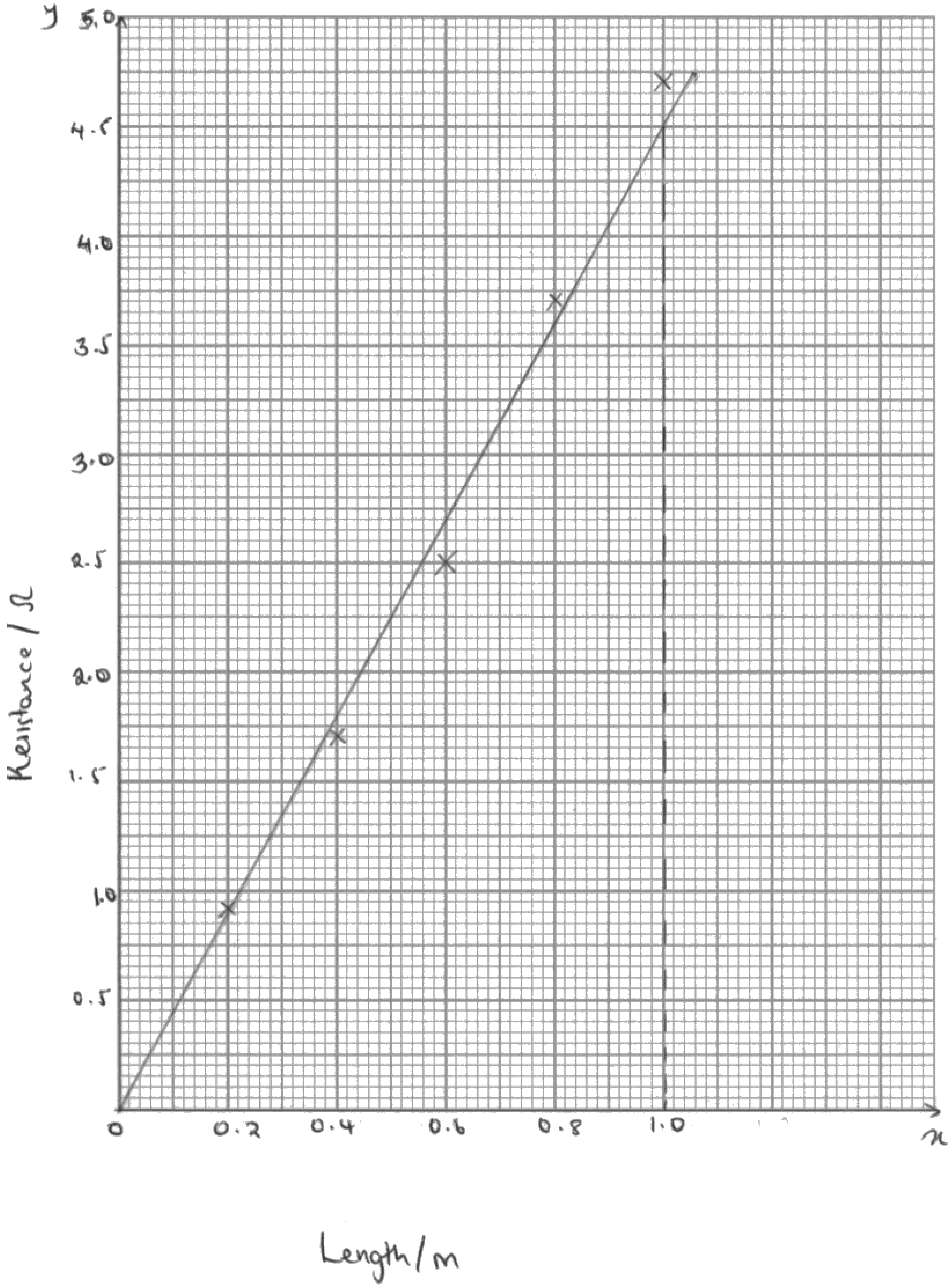
Many students answered part (c)(iii) with a successful calculation of the resistivity. Some students were unable to rearrange the equation R = ρl/A properly and others substituted the cross-sectional area of the wire incorrectly. A large minority of students omitted or mistook the unit for resistivity.

This was an excellent answer.

Length / m	Potential difference / V	Resistance / Ω
1.00	0.52	4.7
0.80	0.41	3.7
0.60	0.27	2.5
0.40	0.19	1.7
0.20	0.1	0.91

(c) (i) Plot a graph of resistance on the y-axis and length on the x-axis and draw a line of best fit.

(4)



(ii) Determine the gradient of the graph.

(2)

$$\text{Gradient} = \frac{\Delta y}{\Delta x} = \frac{\Delta R}{\Delta L} = \frac{4.5}{1.0} = 4.5\ \Omega m^{-1}$$

Gradient = $4.5\ \Omega m^{-1}$

(iii) Use your value for the gradient to calculate a value for the resistivity.

(4)

$R = \rho \frac{L}{A}$ $y = R,\ x = L,\ m = \frac{\rho}{A},\ A = \frac{\pi d^2}{4},\ A = \frac{\pi \times (0.56\times10^{-3})^2}{4}$

$A = 2.46\times10^{-7}\ m^2$

$\frac{R}{L} = \text{gradient}\ \therefore\ \frac{R}{L} = \frac{\rho}{A},\ \Rightarrow 4.5\ \Omega m^{-1} = \frac{\rho\ \Omega m}{2.46\times10^{-7}\ m^2}$

$\rho = 1.12\times10^{-6}\ \Omega m$

Resistivity = $1.12\times10^{-6}\ \Omega m$.

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Examiner Comments

For the gradient the candidate has used, as required, a triangle which is greater than half the drawn line.

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Examiner Tip

It is good practice to show on the graph the triangle used to calculate a gradient.

Question 8 (c) (iv)

Most students responded well to part (c)(iv), showing a good understanding of likely causes of difference between the calculated result and the accepted value.

Paper Summary

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

- Read the question carefully
- Draw scientific diagrams rather than pictures.
- Make sure you have a pencil with a sharp point
- Line of best fit can be a curve
- Don't force a straight line on a graph through the origin
- Remember to justify assertions

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