Cambridge Assessment International Education

Example Responses – Paper 3

Cambridge International AS & A Level Physics 9702

For examination from 2022

Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge International AS & A Level Physics 9702.

This booklet contains responses to all questions from June 2022 Paper 33, which have been written by a Cambridge examiner. Responses are accompanied by a brief commentary highlighting common errors and misconceptions where they are relevant.

The question papers and mark schemes are available to download from the School Support Hub.

9702 June 2022 Question Paper 33

9702 June 2022 Mark Scheme 33

Past exam resources and other teaching and learning resources are available from the School Support Hub.

Question 1

You may not need to use all of the materials provided.

1 In this experiment, you will investigate an electrical circuit.

You have been provided with a wooden strip with a wire attached.

(a) Measure and record the length L of the wire between the nails on the wooden strip, as shown in Fig. 1.1.

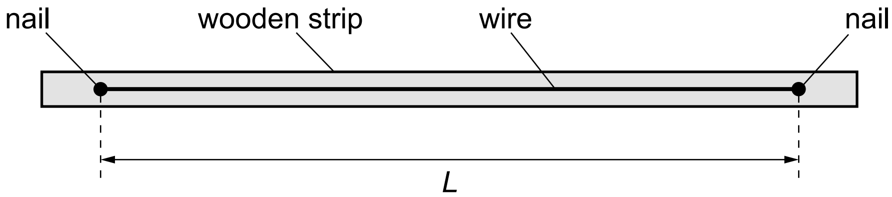


Fig. 1.1

L = ...75.2 cm.......... [1]

(b) You have also been provided with a wire labelled A with crocodile clips at its ends.

- Set up the circuit shown in Fig. 1.2.

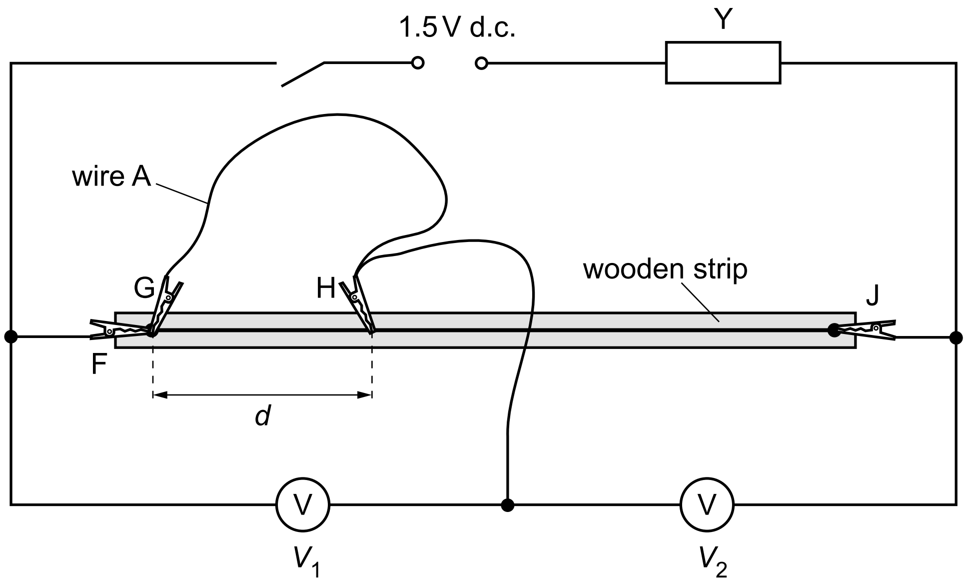


Fig. 1.2

- F, G, H and J are crocodile clips.

  The distance between one of the nails and H is d, as shown in Fig. 1.2. Attach H to the wire on the wooden strip so that d is approximately 20 cm.

- Close the switch.
- Record the value of d and the voltmeter readings V_1 and V_2.

d = 20.0 cm

V_1 = 165 mV

V_2 = 510 mV

- Open the switch.

[2]

(c) Increase d by placing H at different positions on the wire and record V_1 and V_2.
Repeat until you have six sets of readings of d, V_1 and V_2. Include your values from **(b)**.

Record your results in a table. Include values of $\left(\frac{V_2}{V_1}\right)d$ and d^2 in your table.

No.	d/cm	V_1/mV	V_2/mV	$\left(\frac{V_2}{V_1}\right)d$/cm	d^2/cm^2
1	20.0	165	510	61.8	400
2	30.0	257	470	54.9	900
3	40.0	288	374	51.9	1600
4	50.0	297	248	41.8	2500
5	60.0	359	171	28.6	3600
6	70.0	442	88	13.9	4900

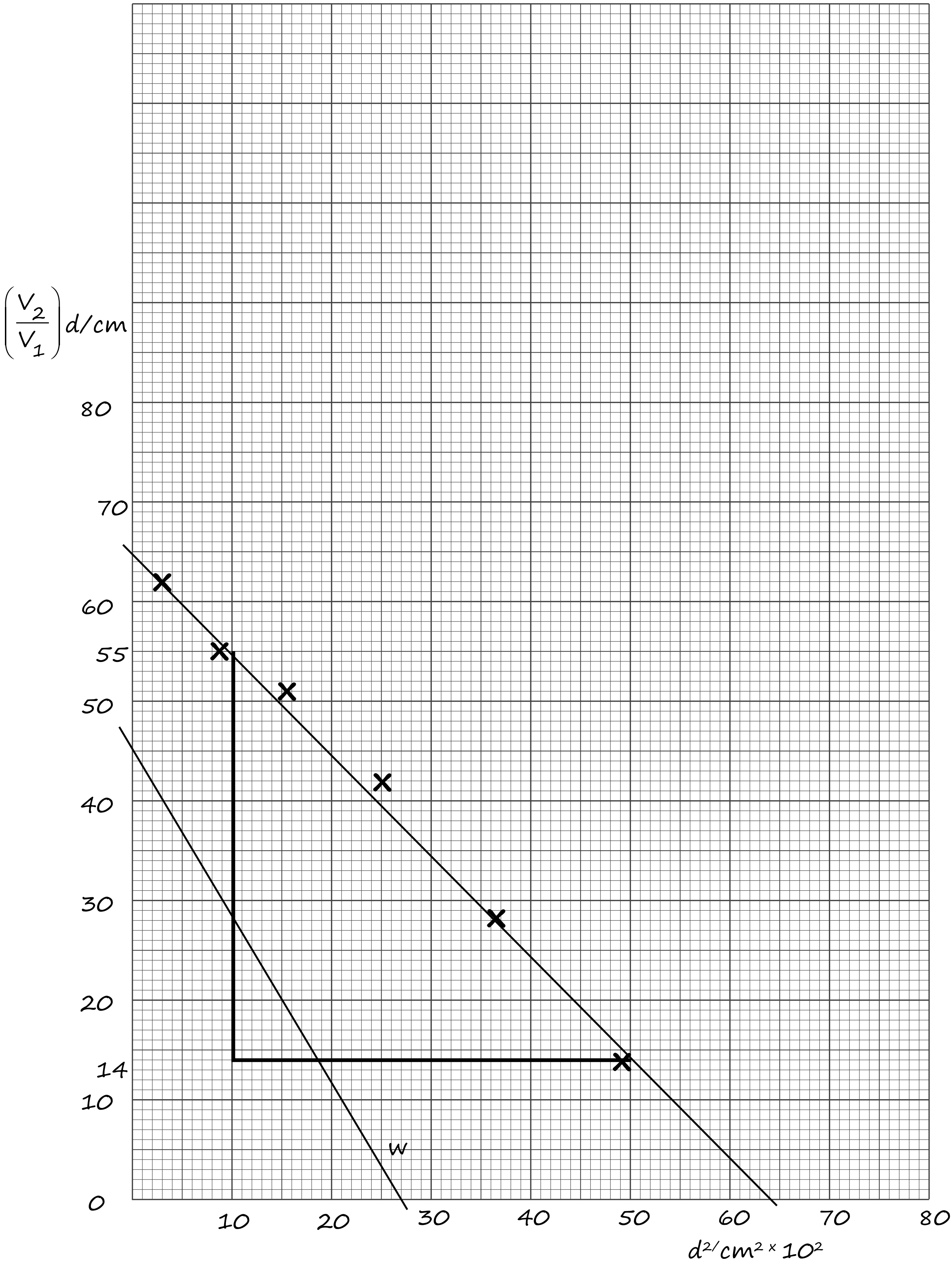
[8]

Examiner comment

The response provides six sets of results over a large range, because candidates were asked to start at d = 20.0 cm and increase their values. The maximum length of the wire is 75.0 cm so it was expected that the candidates increase their d values to at least 65.0 cm. The column headings all have appropriate quantities and units with a separating mark between them. The calculated quantity $(V_2/V_1)d$ is correct to the number of significant figures provided. Three significant figures were used in the calculated quantity (V_2/V_1)d which is consistent with the three significant figures used in the raw data V_2, V_1 and d. The last reading in this example states V_2 to two significant figures; the calculated quantity can be one more significant figure than the least used in the raw data and so is still consistent and can be awarded marks.

(d) **(i)** Plot a graph of $\left(\frac{V_2}{V_1}\right)d$ on the y-axis against d^2 on the x-axis. [3]

(ii) Draw the straight line of best fit. [1]



Examiner comment

The response shows that scales have been chosen so that the points plotted extend across six squares or more in the y-direction and four squares or more in the x-direction. Both axes have been labelled correctly and numbers have been added at regular intervals providing a sensible scale which is easy to read from. All six points from the table have been plotted on the graph grid. Each point has been plotted to the nearest half a small square. The line of best fit is a reasonable fit with two points above, two below and two on the line. The line doesn't need rotation or shifting to give a better fit. All points are within 2.5 cm on the $(V_2/V_1)d$ scale and so the data is awarded marks for quality.

(iii) Determine the gradient and *y*-intercept of this line.

$$grad = \frac{\Delta y}{\Delta x} = -\left(\frac{55-14}{(50-100)\times 10^2}\right) = \frac{-41}{4000}$$

gradient = -0.0103

y-intercept = 65.5

from read off since x = 0 on grid [2]

(e) It is suggested that the quantities V_1, V_2 and d are related by the equation

$$\left(\frac{V_2}{V_1}\right)d = Pd^2 + Q$$

where P and Q are constants.

Using your answers in **(d)(iii)**, determine values for P and Q.
Give appropriate units.

P = $-0.0103\ \text{cm}^{-1}$

Q = $65.5\ \text{cm}$

[2]

(f) Wire A has the same length L as the wire between the nails.

Theory suggests that

$$P = -\frac{1}{L} \quad \text{and} \quad Q = L.$$

A student repeats the experiment using two shorter wires of equal length.

Sketch a second line on the graph to show the expected results.
Label this line W. [1]

[Total: 20]

Question 2

You may not need to use all of the materials provided.

2 In this experiment, you will investigate the motion of two connected masses.

You have been provided with two masses connected by a string.
The larger mass is 100 g and the smaller mass is 10 g.

(a) **(i)** • Set up the apparatus as shown in Fig. 2.1.

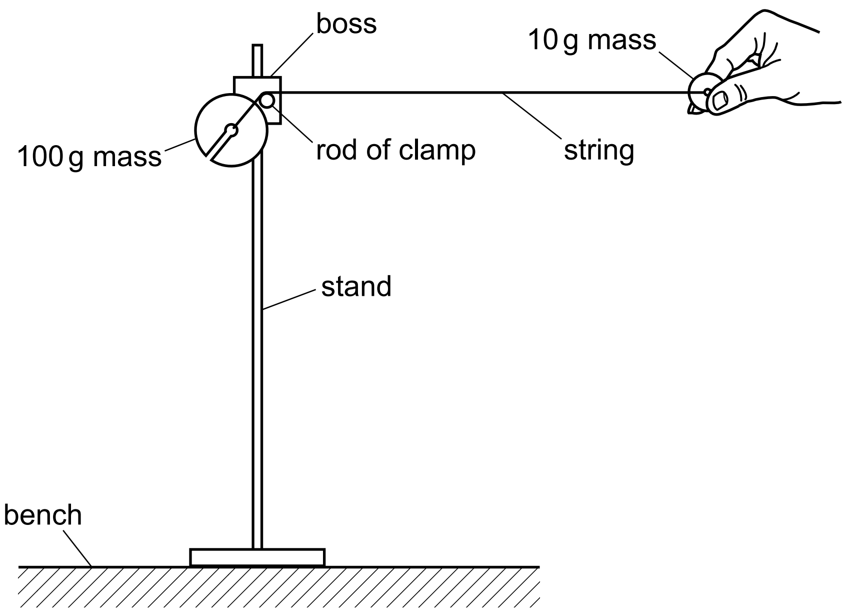


Fig. 2.1

- Hold the 10 g mass so that the string is horizontal and as straight as possible and the 100 g mass is as close to the rod of the clamp as possible. The string should be resting on the rod of the clamp.

When the 10 g mass is released, the 100 g mass will fall downwards.
The 10 g mass will fall and move towards the stand.
The string will wrap itself several times around the rod of the clamp.

You may need to repeat the procedure several times before you see this result.

- Release the 10 g mass.
- The distance fallen by the 100 g mass is *A*, as shown in Fig. 2.2.

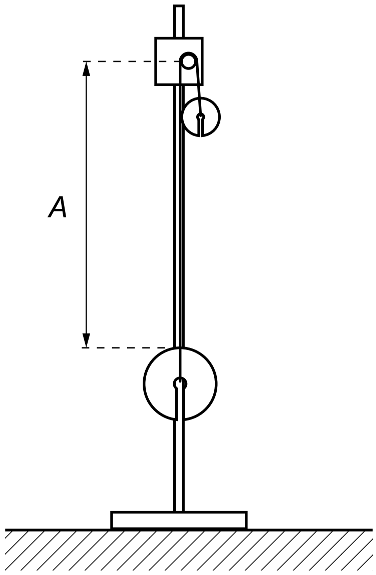


Fig. 2.2

Measure and record *A*.

$$\frac{47.5 + 48.2 + 48.5}{3}$$

A = 48.1 cm [2]

(ii) Estimate the percentage uncertainty in your value of *A*. Show your working.

$$\text{Percentage uncertainty} = \frac{\text{absolute error}}{\text{measured value}} \times 100\%$$

$$= \frac{0.5}{48.1} \times 100 = 1.04\%$$

percentage uncertainty = 1.04 % [1]

Examiner comment

This response recognises that the absolute error in A is not the smallest reading possible, i.e. 1 mm, but several mm to take account of the difficult nature of the measurement. The measurement is difficult because of uncertainty over identifying the top part of the measured length and also, if the mass is touched by the ruler, it will move.

(b) Fig. 2.3 shows the 10 g mass held so that the angle between the string and the vertical is θ.

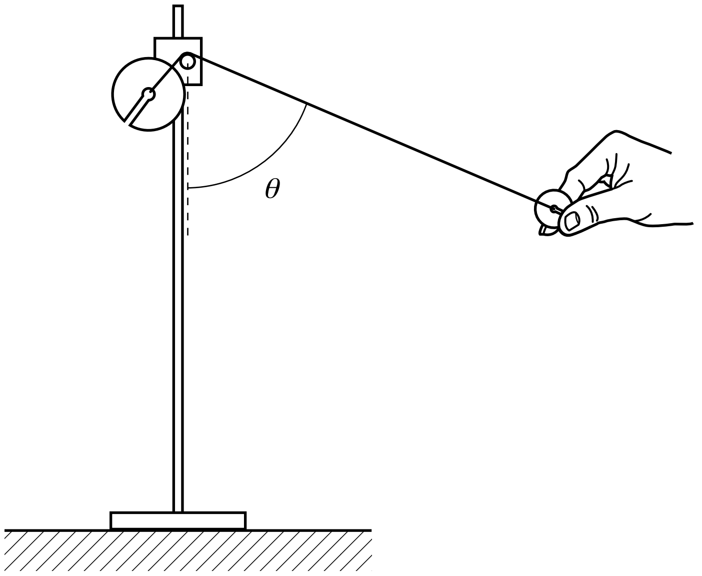


Fig. 2.3

(i)
- Hold the string so that θ is approximately 65°.
- Release the 10 g mass.
- The distance fallen by the 100 g mass is H, as shown in Fig. 2.4.

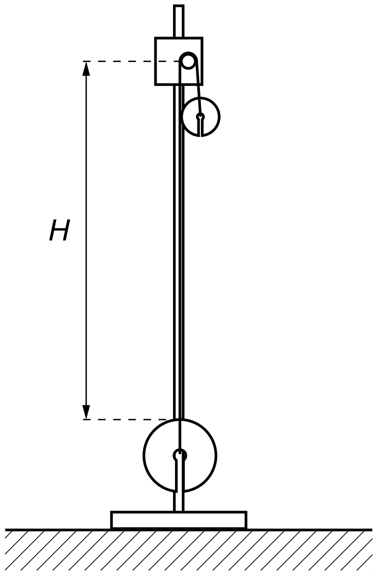


Fig. 2.4

Measure and record θ and H.

θ = 65 °

H = 52.0 cm

[2]

(ii) Calculate $\cos^2\theta$ and $\frac{H}{A}$.

$\cos^2\theta =$ 0.18

$\frac{52.0}{48.1}$

$\frac{H}{A} =$ 1.08

[1]

(c) Repeat **(b)(i)** and **(b)(ii)** with a value of θ of approximately 45°.

$\theta =$ 45 °

$H =$ 54.5

$\cos^2\theta =$ 0.50

$\frac{54.5}{48.1}$

$\frac{H}{A} =$ 1.13

[3]

(d) It is suggested that the relationship between *H*, *A* and θ is

$$\frac{H}{A} = k\cos^2\theta + 1$$

where *k* is a constant.

(i) Using your data, calculate two values of *k*.

$$K_1 : 1.08 = K_1(0.18) + 1$$

$$\frac{1.08 - 1}{0.18} = 0.444$$

$$K_2 : 1.13 = K_2(0.50) + 1$$

$$\frac{1.13 - 1}{0.50} = 0.260$$

first value of *k* = 0.444

second value of *k* = 0.260

[1]

(ii) Justify the number of significant figures that you have given for your values of *k*.

The significant figures for the values of K will be the same as the significant figures for our raw data; H, A and θ.

[1]

Examiner comment

- The response relates the significant figures in the calculated quantity to the number of significant figures used in the stated raw data.
- It was a common misconception to state 'raw data' instead of detailing what that raw data was in terms of the actual quantities. In this case, the mark would be awarded for stating *H*, *A* and θ.

(e) It is suggested that the percentage uncertainty in the values of *k* is 20%.

Using this uncertainty, explain whether your results support the suggested relationship in **(d)**.

$$\text{\% difference in K} = \left(\frac{0.444 - 0.260}{0.352}\right) \times 100\% = 52\%$$

As the percentage difference in K is greater than the percentage uncertainty for the experiment (52% > 20%) my results do not support the suggested relationship.

[1]

Examiner comment

- In **(d)**, two values of *k* are correctly worked out.
- In **(e)**, the response compares their two values of *k* and relates this to the percentage uncertainty of 20% stated for this experiment. The easiest way to do this is to get a percentage difference between the two *k* values and compare this directly with 20%. If the % difference in k is higher than 20%, the results do not support the relationship, as in this case, and if the % difference is lower then the results support the relationship as they lie within the percentage uncertainty of the experiment. It is worth noting that this candidate has used the average *k* on the bottom of their calculation for % difference in *k*. They could also use either *k* value instead.

(f) **(i)** Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1 Two sets of readings are not enough to make a valid conclusion.

2 Difficulty in measuring θ because of the string moving and parallax error.

3 Two masses collide with each other on release.

4 Difficult to judge if the string is horizontal.

[4]

Examiner comment

- The response states the problems encountered either by describing the quantity and the difficulty involved, e.g. problems with the angle such as parallax error, or the practical difficulties of the experiment, e.g. the masses colliding on release or it being difficult to judge whether the string is held horizontally.
- Many responses stated that two readings were not enough to come up with a valid conclusion.

(ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1 Take multiple readings and plot a graph.

2 Use a clamped protractor.

3 Use a longer rod.

4 Use a spirit level to ensure string is horizontal.

[4]

[Total: 20]

Examiner comment

- The solutions need to relate to the difficulties encountered, so the point about the use of a spirit level to ensure the string is horizontal is awarded a mark. Clamping a protractor will improve the measurement of the angle. The use of a longer rod will prevent the masses colliding with the stand. If the examiner could see that the solution will help to improve the experiment, then the marks were awarded.

- The response to **(i)** states that the masses collide. It is doubtful that a longer rod would solve this particular problem, but it will solve the problem of the masses colliding with the stand, and so this response is awarded marks.
- Both **(i)** and **(ii)** are standalone questions and are marked independently, so candidates are awarded marks for thinking about possible solutions that will improve the experiment.

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