

Examiners' Report  
January 2012

GCE Physics 6PH08 01

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## Introduction

The paper was much the same as in previous years, both in format and in content. The paper is set so that the four questions cover the specification as widely as possible and test as many skills as possible.

There was evidence that many candidates had practised on the past papers and are getting better with uncertainties in particular and with the demand of the paper overall. An area for improvement for many is in their description of practical work using technical terms, it is vital at this level for these to be used with precision. There was evidence this year that the candidates' use of plain language is good and this seldom held a candidate back. The most common way to lose marks was using an inappropriate number of significant figures; there should be the same number of SF in the answer as there is in the data. Otherwise all the marks were awarded at some stage and access was good.

## Question 1 (a) (b)

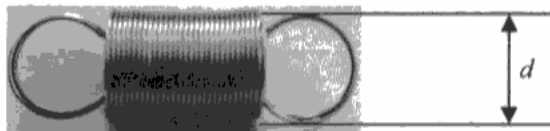
This question is to test the candidates understanding of the use of significant figures in processing data and their understanding of the way uncertainties are generated by the method and the readings. All candidates scored some marks on this question with the good candidates getting 6 out of 7.

The data is to 4 significant figures (SF) so the calculations in a(i) and (ii) and in b(i) that are based on this data should have the same number of SF. The uncertainty in a(iii) should use either 0.04 or 0.05 since this is half the range of the data given, credit was given to candidates who used the whole range of 0.09 mm.

Candidates who misunderstood the question and used 32.5 loops, forgetting that there were two loops *at each end of the spring*, lost the mark in (i) but were given error carried forward (ecf) for (ii).

This is an example of how the best candidates lay out their work. The calculations are easy to follow with every thought explained.

- 1 The spring shown below is made up of loops of wire. There are two extra loops on each end.



A student wants to determine the total length of wire used to make the spring.

She only has digital callipers.

She decides to find the length of wire,  $l$ , in each loop and multiply this by the total number of loops.

The length of wire,  $l$ , is given by  $l = \pi d$  where  $d$  is the diameter of each loop.

- (a) She obtains the following values for  $d$ .

$d/\text{mm}$	15.52	15.56	15.48	15.55	15.47
---------------	-------	-------	-------	-------	-------

- (i) Use these values to calculate a mean value for  $d$ .

(1)

$$d_{\text{mean}} = \frac{15.52 + 15.56 + 15.48 + 15.55 + 15.47}{5} = 15.52 \text{ mm}$$

- (ii) Hence calculate a value for  $l$ .

(1)

$$l = \pi \times 15.52 = 48.76 \text{ mm}$$

- (iii) Estimate the percentage uncertainty in your value for  $l$ .

(1)

$$\% \text{ Uncertainty in } l = \% \text{ Uncertainty in } d = \frac{(15.56 - 15.47) / 2}{15.52} \times 100 = 0.290\%$$

(b) There are 30.5 loops in the main part of the spring. At both ends of the spring there are 2 extra loops. These loops are the same size as the main ones.

(i) Calculate the total length of wire in the spring.

(1)

$$\begin{aligned}\text{Total length} &= (30.5 + 2 \times 2) \times 48.76 \\ &= 1682.22 \text{ mm} \\ &= 1.682 \text{ m.}\end{aligned}$$

(ii) The student forgets the 2 extra loops at both ends.

Estimate the percentage uncertainty in her value for the total length of wire caused by this error.

(1)

$$\% \text{ Uncertainty} = \frac{4 \times 48.76}{1682.22} \times 100 = 11.59\%$$



**ResultsPlus**

**Examiner Comments**

Significant figures are handled well and it is clear that the candidate is considering both ends of the spring from their answer to b)(i).



**ResultsPlus**

**Examiner Tip**

The examiner marks the candidates' last answer and this is the place to adjust the SF and check on the units.

This is an example of error carried forward.

(b) There are 30.5 loops in the main part of the spring. At both ends of the spring there are 2 extra loops. These loops are the same size as the main ones.

(i) Calculate the total length of wire in the spring.

(1)

$$\begin{aligned} \text{Total length of wire} &= 48.76 \times (30.5 + 2) \\ &= \underline{1585 \text{ mm}} \text{ [to 4 s.f.]} \end{aligned}$$

(ii) The student forgets the 2 extra loops at both ends.

Estimate the percentage uncertainty in her value for the total length of wire caused by this error.

(1)

$$\begin{aligned} \% \text{ uncertainty} &= \frac{1585 - 1487}{1585} \times 100 \\ &= \underline{6.2\%} \end{aligned}$$



### ResultsPlus Examiner Comments

The candidate forgets that there are 2 loops at each end and uses 32.5 for the length calculation but still gets the mark for the uncertainty calculation since they use 2 in 32 as the uncertainty.

## Question 1 (c)

Candidates were expected to use the callipers to measure along the spring thus measuring 32 diameters and getting more precision than the callipers give by measuring one diameter alone. Many candidates forgot that the only instrument available was the callipers but they were awarded the mark if they mentioned a suitable precaution. Zero error is a suitable precaution that few students seem to consider.

(c) She now wants to measure the diameter of the wire that makes the spring.

Describe how you would do this as accurately as possible.

(2)

- Take measurements at different ~~or~~ orientation of the wire.
- Repeat measurements and calculate average diameter
- Use micrometer screw gauge ( $\pm 0.01\text{mm}$ )



**ResultsPlus**  
Examiner Comments

This candidate describes well a good technique but using the wrong instrument and so only scores one mark.

## Question 2 (a)

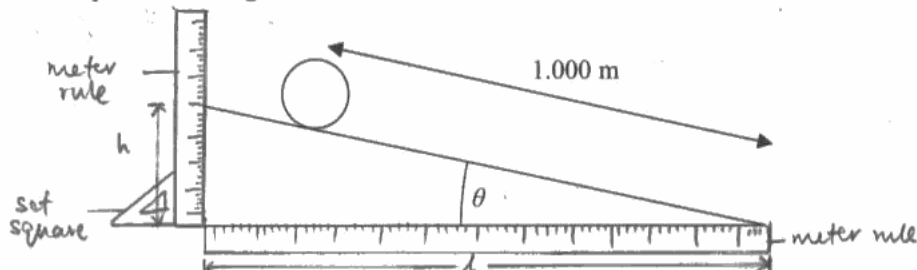
This question looks at the trigonometrical method of measuring angle by measuring two lengths and using a sine or a cosine. A mark was awarded in (i) for showing one length and the other for a trigonometrical expression that agreed with the diagram.

The precision in this method comes from the fact that the measured lengths are long and a metre rule is very precise over this range.

The examiner will read the words and look at the diagram together to mark this question.

2 A student measures the acceleration of a drinks can as it rolls down a ramp. He wants to use this acceleration to find a value for  $g$ .

(a) The ramp makes an angle  $\theta$  with the bench as shown.



(i) Describe an accurate method to determine the angle  $\theta$ . You may add to the diagram if you wish.

(2)

Trigonometry method is to be used. The height,  $h$  and length,  $l$  as shown above are measured using a metre rule. Set square is used for vertical arrangement.  $\theta$  can be found from  $\tan^{-1}(\frac{h}{l})$

(ii) Explain why your method gives good precision.

(2)

The metre rule reads to a precision of 0.1 cm (1mm). Since the order of length and height is much larger than the likely error of 0.1 cm, percentage uncertainty is low compared to protractor, with likely error of  $1^\circ$  or  $2^\circ$



### ResultsPlus

#### Examiner Comments

(i) Distances are shown carefully marked and even though two rules might be needed to measure the horizontal length,  $l$ , the diagram explains exactly how the distances will be accurately measured. The trigonometry agrees with the diagram to give the correct answer.

(ii) An excellent response in every way.



### ResultsPlus

#### Examiner Tip

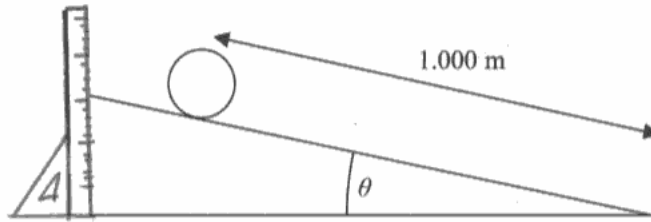
Whenever the question invites you to add to the question you should do so - it is the easiest way of getting the mark.



The diagram shows immediately that the candidate has the right idea.

- 2 A student measures the acceleration of a drinks can as it rolls down a ramp. He wants to use this acceleration to find a value for  $g$ .

(a) The ramp makes an angle  $\theta$  with the bench as shown.



- (i) Describe an accurate method to determine the angle  $\theta$ . You may add to the diagram if you wish.

Measure the height <sup>(h)</sup> from which the ball is placed ~~Use a~~ <sup>(2)</sup>  
~~set square~~ using a ruler. Use a set square to ensure  
that ruler is perfectly vertical. Use  $\sin \theta = \frac{h}{1.0}$  to find  
the  $\theta$ .



### ResultsPlus Examiner Comments

- (i) The trigonometry is correct if  $h$  is to be measured to the bottom of the can/ball but since the height shown is wrong and  $h$  is not shown on the diagram the second mark cannot be given as the examiner cannot split the contradiction between the words and the diagram.

## Question 2 (b) (c) (d)

Here the candidate is taken through the analysis of the experiment. The demand increases steadily with the marks for part (b) and (c)(i) being relatively straightforward and ending with a comparison of percentage uncertainty and percentage difference to justify a conclusion. This last part was done well and many candidates scored the mark. Many candidates also handled the uncertainties well, combining them correctly for both marks. Significant figures and units are important in this sort of question and generally candidates managed these well.

The first two marks for part b) are straightforward, the uncertainty in a single measurement using a metre rule is the precision of the instrument and either 1 or 2 mm is appropriate giving 0.1% or 0.2%. Nearly all candidates got the method mark, the commonest error was to change the method by suggesting light gates or similar.

Here a candidate who knows how to do the physics loses marks by missing out important detail, or getting it wrong.

(c) The student determines the mean value for  $t$  as 1.20 s with an uncertainty of 0.10 s.

He assumes the acceleration  $a$  is given by  $a = 2s/t^2$ .

(i) Use his value to calculate the acceleration of the can. (1)

$$a = \frac{2s}{t^2}$$

$$a = \frac{2(1)}{(1.20)^2}$$

$$a = 1.38889 = 1.39 \text{ ms}^{-1}$$

(ii) Estimate the overall percentage uncertainty in his value for the acceleration. (2)

$$\% \text{ uncertainty for time} = \frac{0.10}{1.20} \times 100 = 8.3\%$$

$$\% \text{ uncertainty for } s = 0.1\%$$

$$\begin{aligned} \text{Overall } \% \text{ uncertainty} &= 0.1 + 8.3 \\ &= 8.43\% \end{aligned}$$

(d) The student assumes that the acceleration of the can is given by  $a = g \sin \theta$ .

(i) Use this equation to calculate a value for  $g$  when  $\theta = 10.0^\circ$ .

(1)

$$\frac{v^2}{(1.70)^2} = g \sin(10)$$

$$1.39 = g (0.174)$$

$$g = 8.00 \text{ ms}^{-2}$$

(ii) Calculate the percentage difference between this value for  $g$  and the accepted value for  $g$ .

(1)

$$\% \text{ difference} = \frac{8.00}{9.81} \times 100 = 81.5\% \quad \% \text{ difference} = \frac{9.81 - 8.00}{9.81} \times 100 = 18.5\%$$

(iii) Explain whether your answers in (c)(ii) and (d)(ii) support the assumption that  $a = g \sin \theta$ .

(1)

Does not support assumption as percentage difference is greater than 10%.



## ResultsPlus

### Examiner Comments

c)(i) Although the unit is wrong there is no penalty on this occasion and the SF match the data so the mark is awarded. (ii) The percentage uncertainty for time is correct but should be doubled since the quantity is squared in the expression above.

d)(i) There is a unit penalty here. (ii) This is correct. (iii) The figure of 10% is only a guideline if there are no other comparisons to be made, here the %U should be used to justify the conclusion - as the question asks.



## ResultsPlus

### Examiner Tip

Take care with units and SF.

Here the candidate lays out the work in logical, if untidy, fashion and gets the marks.

(c) The student determines the mean value for  $t$  as 1.20 s with an uncertainty of 0.10 s.

He assumes the acceleration  $a$  is given by  $a = 2s/t^2$ .

(i) Use his value to calculate the acceleration of the can.

(1)

$$a = \frac{2s}{t^2} = \frac{2(1.000m)}{(1.20s)^2}$$

$$= 1.39 \text{ ms}^{-2}$$

(ii) Estimate the overall percentage uncertainty in his value for the acceleration.

(2)

$$\begin{aligned} \% \text{ uncertainty for } a &= \% \text{ uncertainty of } s + \% \text{ uncertainty for } t \\ &= (0.1)\% + 2(\cancel{0.10} \times 8.33)\% \\ &= 16.8\% \end{aligned}$$

(d) The student assumes that the acceleration of the can is given by  $a = g \sin \theta$ .

(i) Use this equation to calculate a value for  $g$  when  $\theta = 10.0^\circ$ .

(1)

$$a = g \sin \theta \Rightarrow g = \frac{a}{\sin \theta}$$

$$\Rightarrow g = \frac{1.39}{\sin 10.0^\circ} = 8.00 \text{ ms}^{-2}$$

(ii) Calculate the percentage difference between this value for  $g$  and the accepted value for  $g$ .

(1)

$$\% \text{ difference} = \frac{9.81 - 8.00}{8.91} \times 100 = 20.3\%$$

(iii) Explain whether your answers in (c)(ii) and (d)(ii) support the assumption that  $a = g \sin \theta$ .

(1)

Since the % difference is greater than the % uncertainty,  $(a = g \sin \theta)$  does not support.



## ResultsPlus

### Examiner Comments

In c)(ii) they should say 'uncertainty in  $t$  squared' but they get the second mark for correctly doubling their calculation which is not shown but as a bald answer still gets the first mark.

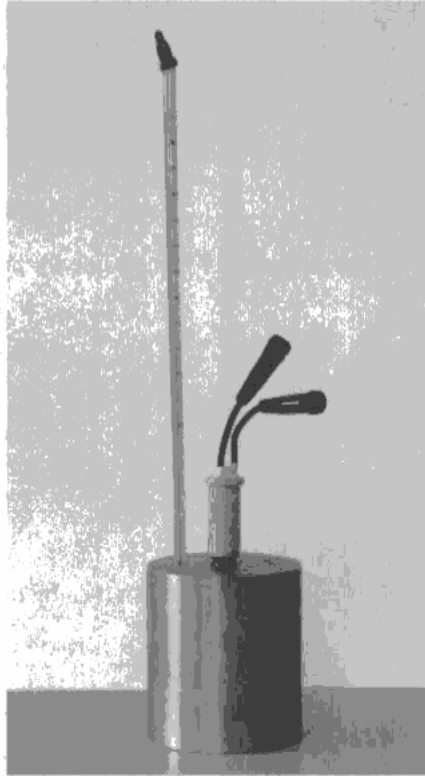
d)(ii) The percentage difference calculation should use the average value - here 8.91 - only when neither of the values is known. Here  $g$  has a definite value and that should be used to divide the difference.

d)(iii) Exactly the right reasoning.

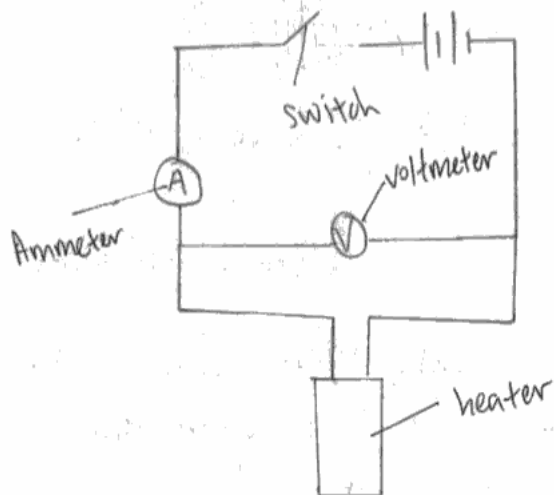
### Question 3a

There is quite a lot of work for just one mark here but it is really only GCSE work and the mark is for putting it in context.

- 3 A student wants to determine the specific heat capacity of aluminium. She heats a block of aluminium by supplying electrical energy to a heater that is inserted into the block as shown.



- (a) Draw the electrical circuit she should use.



**ResultsPlus**  
Examiner Comments

Nice clear and correct diagram.

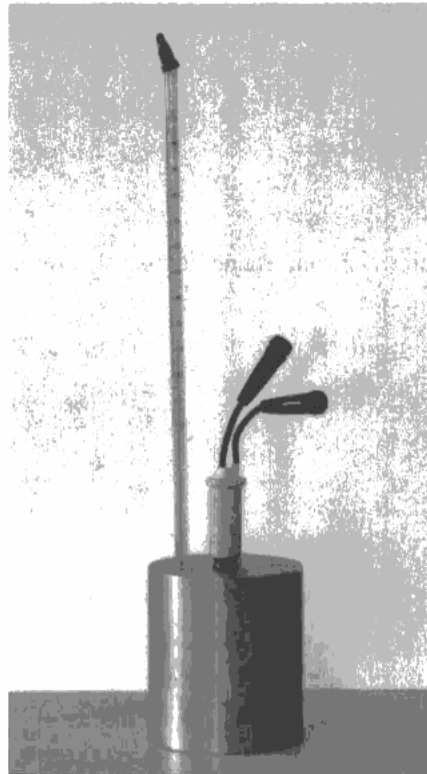


**ResultsPlus**  
Examiner Tip

A ruler and a sharp pencil make your diagram easier to mark.

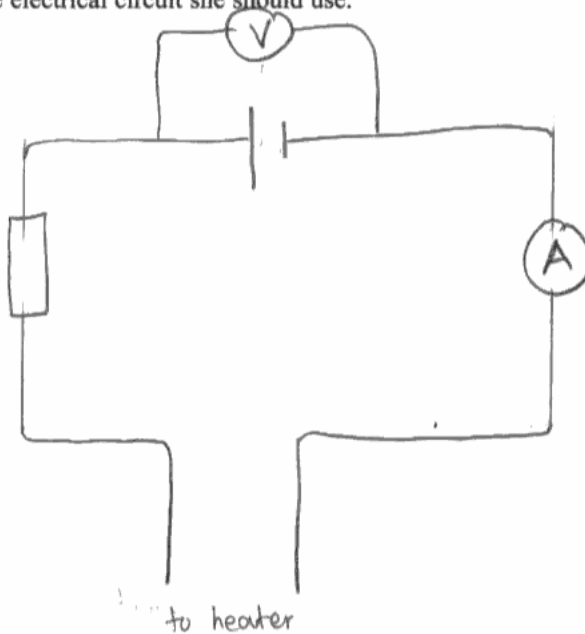
This diagram has got a bit out of control.

- 3 A student wants to determine the specific heat capacity of aluminium. She heats a block of aluminium by supplying electrical energy to a heater that is inserted into the block as shown.



- (a) Draw the electrical circuit she should use.

(1)





**ResultsPlus**  
Examiner Comments

In the large diagram the voltmeter is not measuring the voltage across the heater and in the small one there is no voltmeter. This one might have got the mark for the lagging in b) if it had been labelled.



**ResultsPlus**  
Examiner Tip

Don't give the examiner a choice of answers.

### Question 3 (b)

This was an experiment that many candidates had seen before and they knew a lot about it. As can be seen from the mark scheme there are eleven ways to score the six marks for this part and many candidates found a lot of these. A high scoring question.

A logical sequence that is described well. Much is not mentioned but the candidate still scores 5 marks.

(b) She writes the following plan

$$c = \frac{Q}{m\Delta\theta}$$

Measure the temperature of the block at the start  
Turn on the electric current  
Determine the energy flowing for a certain time  
Turn off the current and measure the temperature  
This will give me the specific heat capacity if I divide the total energy by the mass and the temperature rise

Write an improved plan that includes details of the method to be used and any precautions needed to produce an accurate value for the specific heat capacity of aluminium.

- (6)
- Firstly, measure the <sup>Initial Temperature ( $\theta_i$ )</sup> ~~initial temperature~~ of the Aluminium Block by using a thermometer. Then place the block on a top-pan balance to find out the mass ( $m$ ) of the Aluminium Block. place the heater ~~inside~~ and thermometer inside the Block and
  - Next switch on the power supply, ~~and~~ Record down the values of the current ( $I$ ) and the voltage ( $V$ ) flowing through the circuit, and start timer/stopwatch.
  - Allow the aluminium block to heat up



- ~~Allow~~ After a certain period of time, switch off the heater and record down the ~~the~~ time taken ( $T$ ) on the stopwatch as well as the final Temperature ( $\theta_f$ ) of the Aluminium Block on the Thermometer

- Next determine the value of  $\Delta\theta$  by using the formula  $\Delta\theta = \theta_f - \theta_i$  (final Temperature minus Initial Temperature)

- The specific heat capacity of Aluminium can then be found by using the formula  $c = \frac{VIT}{m\Delta\theta}$

- To reduce heat loss of Aluminium Block, place a layer of lagging around the Aluminium Block.

(Total for Question 3 = 7 marks)



**ResultsPlus**

**Examiner Comments**

This candidate makes a common mistake with the final temperature. The block should be left after the current is turned off as the temperature will continue to rise. It is the final steady temperature or the highest temperature that is required.



**ResultsPlus**

**Examiner Tip**

Using technical terms with precision is necessary for responses to this sort of question at this level.

The best thing to do is practise.

Write an improved plan that includes details of the method to be used and any precautions needed to produce an accurate value for the specific heat capacity of aluminium.

(6)

The student should set-up the apparatus. At first the temperature of the aluminium block should be taken at room temperature. After that the circuit should be switched on, as the current is flowing, the student should keep an eye on the thermometer and the temperature. In order to determine the energy flowing for a certain time, the student should note the time required for a temperature rise. Then taking the reading from the voltmeter and ammeter and using the equation  $W = VIt$ . She will be able to find the energy. After turning off the current, she should note the temperature rise. Then using the formula  $\Delta E = mc\Delta\theta$ , she can find the specific heat capacity by making 'c' the subject.



## ResultsPlus

### Examiner Comments

This candidate writes good English but fails to mention much physics. This is an example of a candidate giving a response that might attract marks in a lower level examination but at A2 there is insufficient hard detail.



## ResultsPlus

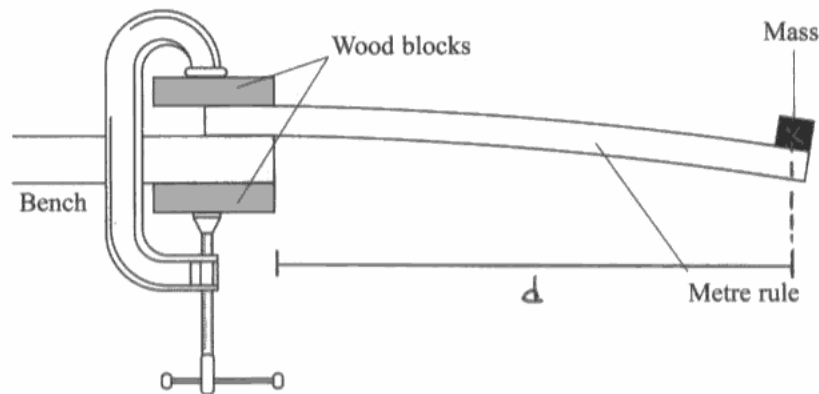
### Examiner Tip

Lay out your answer using bullet points. It is easier for you to order your ideas and it is easier to mark and so gives you the credit.

### Question 4 (a) (i)

Many candidates showed the measuring instruments they would use which is helpful but when answering this type of question the length to be measured must be labelled accurately. Here it is the horizontal distance to the centre of mass.

- 4 A metre rule is clamped to the bench and a mass is attached to the end as shown. The arrangement is called a cantilever.



When pulled down a short distance and released, the cantilever will oscillate. The period of oscillation  $T$  will depend on the distance  $d$  of the mass from the clamped end, providing the mass on the end is kept constant.

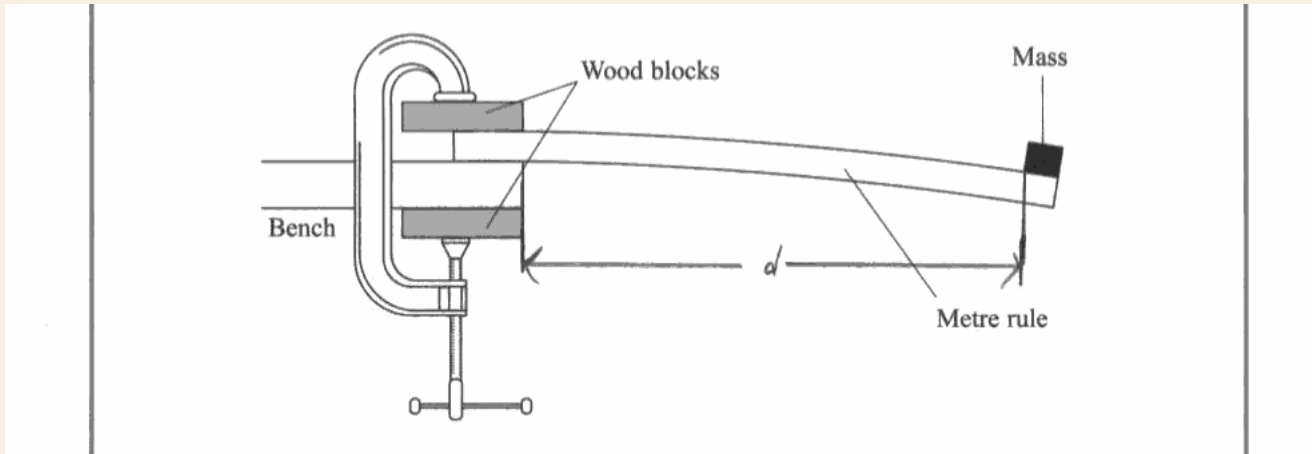
- (a) (i) Add to the diagram to show how you would measure the distance  $d$ .

(1)



**ResultsPlus**  
Examiner Comments

The dimension is clearly marked and correct.



**ResultsPlus**  
Examiner Comments

Dimension is clearly shown but not to the centre of the mass, so, no mark.

## Question 4 (a) (ii)

It is expected that candidates will have done some practical work involving timing oscillations and any of the techniques employed can be described here.

(ii) Describe how you would use a stopclock to determine an accurate value for  $T$ . (2)

Measuring for 10 oscillations using a stopclock. Repeat the experiment for 3 ~~times~~ times and takes the average reading. Then, divide the value of obtained ~~by~~ by 10, to attain the period of oscillation,  $T$ .



**ResultsPlus**  
Examiner Comments

Although the grammar is not good the method is clearly described.

This

(ii) Describe how you would use a stopclock to determine an accurate value for  $T$ . (2)

I will measure the time taken ~~for~~ for 20 complete oscillations and then I will divide it by 20 in order to find ~~the~~ the value of  $T$ .



**ResultsPlus**  
Examiner Comments

This is a good technique but it is only one reading. Repeat readings are necessary so that anomalies can be identified and a mean value can be found.

### Question 4 (b) (i)

The precision of an instrument is the smallest measuring division.

(b) The stopclock has a precision of 0.01 s.

(i) State what is meant by this.

(1)

The smallest value that can be recorded is 0.01 s



**ResultsPlus**  
Examiner Comments

This is acceptable.

(b) The stopclock has a precision of 0.01 s.

(i) State what is meant by this.

(1)

Means the stopclock get measure up to 0.01 s, it is the smallest detail it can measure.



**ResultsPlus**  
Examiner Comments

The idea of measuring a time *up to* 0.01 s is curious but conveys the right idea. Strengthened by the second comment.

### Question 4 (b) (ii)

The best way to justify your choice of measuring instrument is to consider the likely percentage uncertainty in your measurement. This can be because of the range of the measurement or because of the technique used.

(ii) State why this is a suitable instrument for this measurement.

(1)

Because it has a precision greater than the normal human reaction time.



**ResultsPlus**  
Examiner Comments

Here the precision is suitable since it is a hand operated device and the uncertainty of the method is likely to be about 0.1 s.

(ii) State why this is a suitable instrument for this measurement.

(1)

As the time of 10 complete oscillations will be several seconds the percentage uncertainty would be low.



**ResultsPlus**  
Examiner Comments

Here the range is suggested. The candidate got the mark but it would be better to say that the percentage uncertainty will be below 1%.

### Question 4 (c) (i)

In this standard piece of work it is necessary to put the log version of the equation into exactly the same shape as the equation  $y = mx + c$ . So the gradient should be written immediately after the equals sign. Alternatively the equation can be written  $y = c + mx$  to suit the derivation. The best responses write  $y = mx + c$  directly below the derived log equation so that there can be no doubt. It is also a good idea to say that the gradient is a constant thus ensuring a straight line is derived.

(c) It is suggested that  $T = p d^q$  where  $p$  and  $q$  are constants.

(i) Explain why a graph of  $\ln T$  against  $\ln d$  should be a straight line. (1)

$\ln T = q \ln d + \ln p$  is a straight line in the form of  $y = mx + c$   
where  $m = q$ , and  $c = \ln p$



**ResultsPlus**  
Examiner Comments

The question tells us that  $q$  is a constant so identifying it with  $m$  is enough given that both equations have the same layout.



### Question 4 (c) (ii)

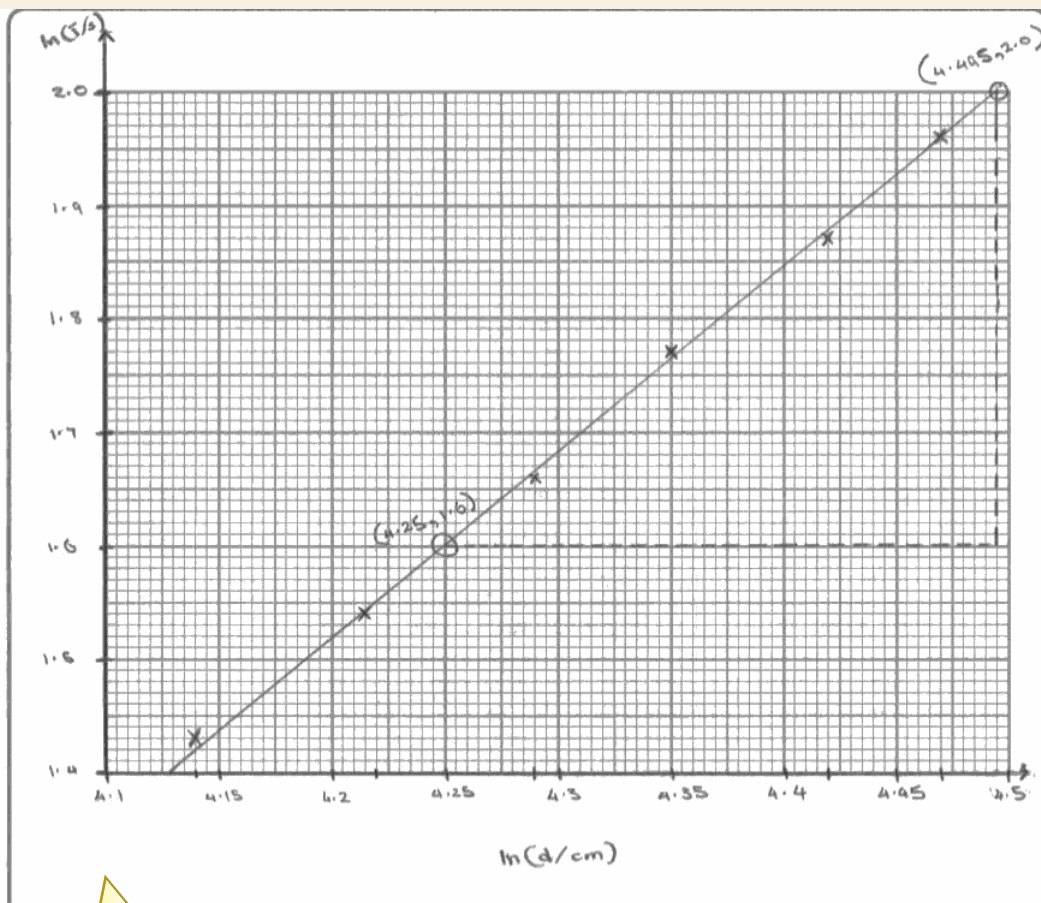
'Determine a value for the gradient' is the best response for this very straightforward mark.

### Question 4 (d)

This is always the part of the paper that differentiates most successfully. The skills required and the way they are judged are usually similar but candidates find ways to get them wrong every year. d)(iii) was something of an innovation this year, it is linked with the idea of Q2 d)(iii) in evaluating a conclusion. The idea was to judge from the data by seeing how close the points lay to the line of best fit. If the points lie close to the line then the conclusion is likely to be valid.

The graph should be used with as many SF as can be accommodated and the plots should extend across the whole grid. The data must be quoted to 3 or 4 significant figures. Although 4 SF is not justified it does make a difference to the plotting when, as here, the first SF of the log values don't change, however 3 SF was not penalised. Tabulated data values should not be used in gradient calculations, candidates are expected to read from the BFL, hence the need for easy scales. The BFL could be extended across to the edges of the grid so that two of the values used in the gradient calculation were very easy to read.

An excellent example of graph plotting.



**ResultsPlus**  
Examiner Comments

Using the fourth SF would be helpful as it would refine the plotted positions. The gradient calculation should use a bigger triangle. It would be easiest if it included the bottom edge of the grid at 4.129, 1.4

Here the candidate gets in a tangle with their gradient.

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

$d/\text{cm}$	Mean $T/\text{s}$	$\ln d / \text{cm}$	$\ln T / \text{s}$
87.7	7.23	<del>4.5</del> 4.47	1.98
82.7	6.49	<del>4.4</del> 4.42	1.87
77.7	5.85	<del>4.4</del> 4.35	1.77
72.7	5.26	<del>4.3</del> 4.29	1.66
67.7	4.66	<del>4.2</del> 4.22	1.54
62.7	4.16	<del>4.1</del> 4.14	1.43

- (i) Plot a graph on the grid opposite to show that these data are consistent with  $T = p d^q$ .

Use the columns provided to show your processed data.

(4)

- (ii) Use your graph to find a value for  $q$ .

(2)

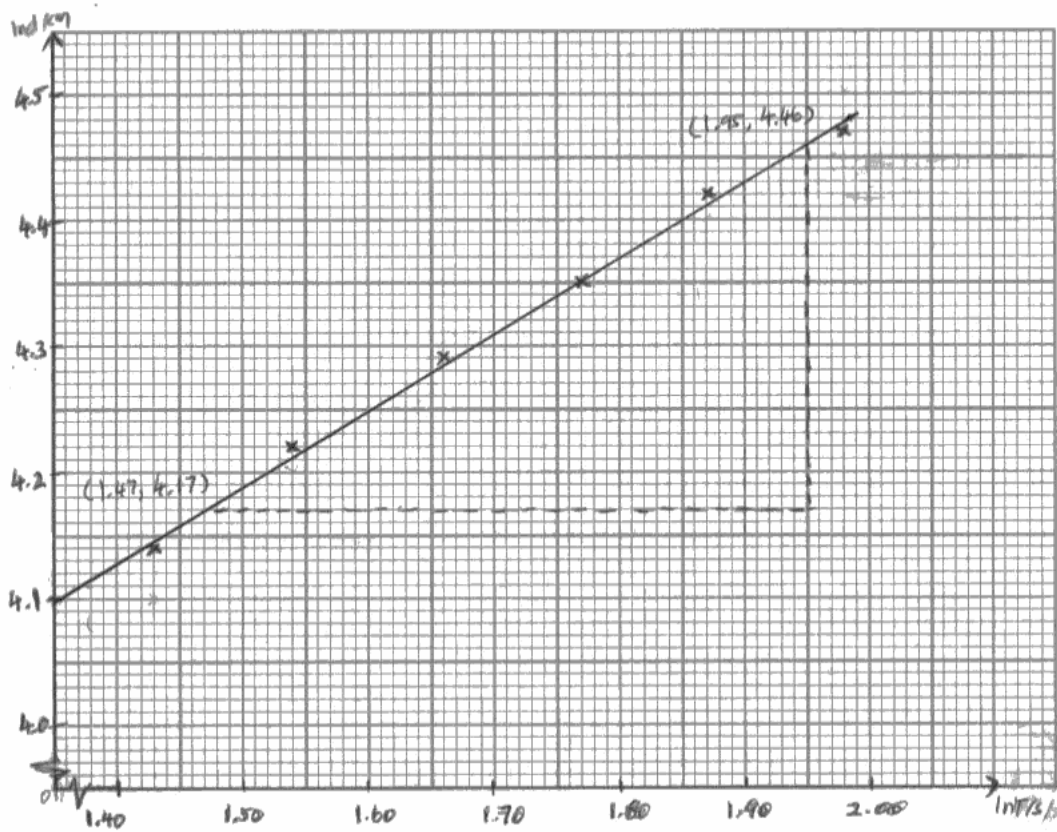
$$q = \text{gradient} = \frac{4.46 - 4.17}{1.95 - 1.47}$$

$$= 0.604$$

- (iii) Comment on the validity of your value.

(1)

value is valid as most of the points tend to a straight line.



**ResultsPlus**  
Examiner Comments

The graph is clear but the labels are not in the correct format,  $\ln(T/s)$ . The gradient triangle is not quite large enough and would be better if it extended to the edge of the grid. The axes are reversed but the gradient calculation is not, giving the inverse of the correct value for  $q$ .

The response for (iii) is just enough.



**ResultsPlus**  
Examiner Tip

Choose a simple scale and check the axes are the right way round and correctly labelled.

## **Paper Summary**

Generally the marks were a little higher this year and there were many good answers, but even the best candidates failed to produce good answers to all four questions.

The best preparation for this paper is to do some practical work in a laboratory. It does not need to be technically demanding nor use complex apparatus but it is vital that the candidates can draw on direct personal experience in answering the questions. Physics is a practical subject and the candidates must experience that.

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