

1

A student carries out an investigation using a metre rule as a pendulum.

(a) **Diagram 1** shows a metre rule.

Diagram 1



(i) Draw, on **Diagram 1**, an **X** to show the position of the centre of mass of the rule.

(1)

(ii) State what is meant by the 'centre of mass of an object'.

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(1)

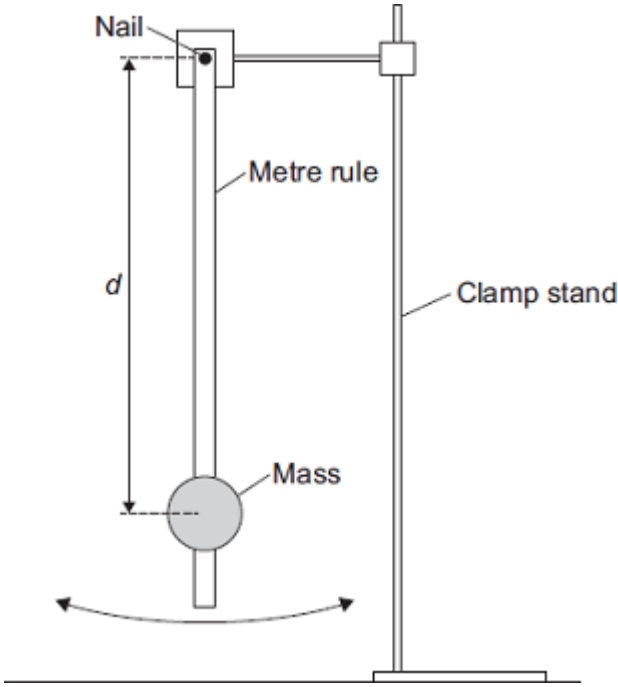
(b) The student taped a 100 g mass to a metre rule.

She set up the apparatus as shown in **Diagram 2**.

She suspended the metre rule from a nail through a hole close to one end, so she could use the metre rule as a pendulum.

The distance d is the distance between the nail and the 100 g mass.

Diagram 2



(i) Draw, on **Diagram 2**, a **Y** to show a possible position of the centre of mass of the pendulum.

(1)

- (ii) The student carried out an investigation to find out how the time period of the pendulum varies with d .

Some of her results are shown in the table.

Time for 10 swings in seconds					
d in cm	First test	Second test	Third test	Mean value	Mean time for 1 swing in seconds
10.0	15.3	15.4	15.5	15.4	1.54
30.0	14.7	14.6	14.7	14.7	1.47
50.0	15.3	15.6	15.4	15.4	1.54
70.0	16.5	16.6	16.5		

Complete the table.

You may use the space below to show your working.

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(3)

(iii) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Describe how the student would carry out the investigation to get the results in the table in part (ii).

You should include:

- any other apparatus required
- how she should use the apparatus
- how she could make it a fair test
- a risk assessment
- how she could make her results as accurate as possible.

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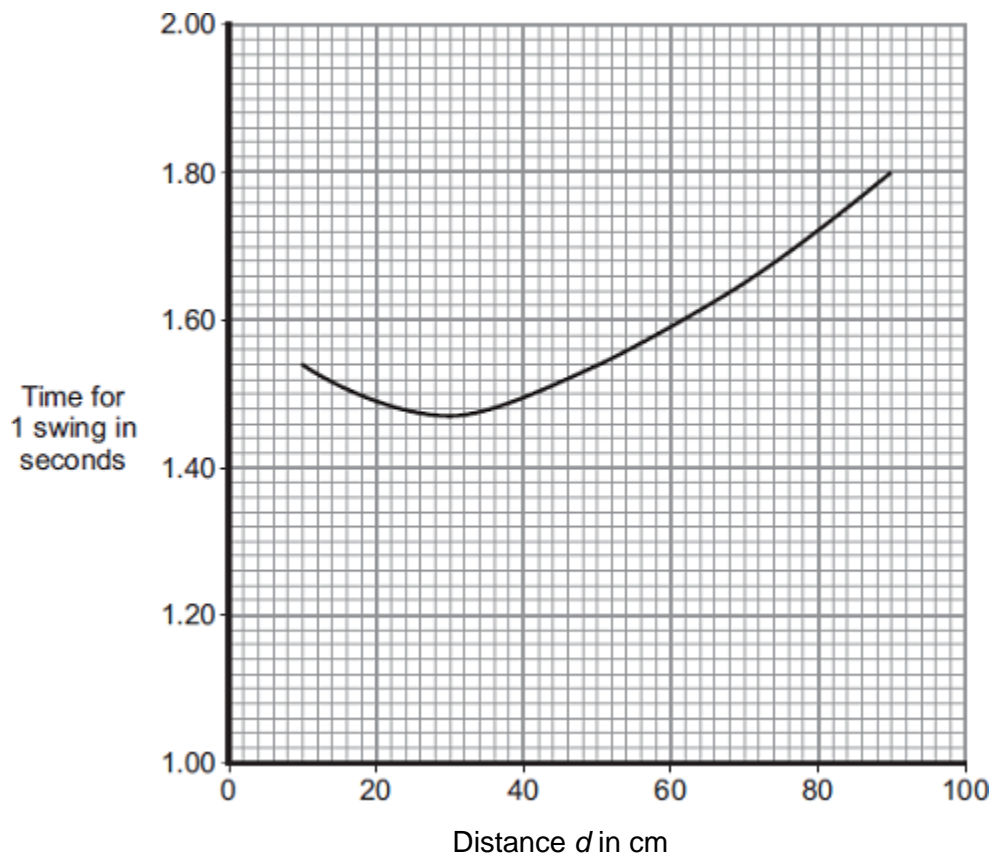
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(6)

(c) A graph of the student's results is shown below.



(i) Describe the pattern shown by the graph.

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(2)

- (ii) The student thinks that the measurements of time for $d = 10$ cm might be anomalous, so she takes a fourth measurement.

Her four measurements are shown below.

15.3 s 15.4 s 15.5 s 15.3 s

State whether you consider any of these measurements to be anomalous.

Justify your answer.

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(2)
(Total 16 marks)

Mark schemes

- | | | |
|---|--|---|
| 1 | (a) (i) X placed at 50 cm mark | 1 |
| | (ii) <u>point</u> at which mass of object may be (thought to be) concentrated | 1 |
| | (b) (i) Y placed between the centre of the rule and the upper part of mass | 1 |
| | (ii) 16.5 | |
| | <i>allow for 1 mark</i>
$(16.5 + 16.6 + 16.5) / 3$ | 2 |
| | 1.65 | |
| | <i>value consistent with mean value given</i>
<i>only penalise significant figures once</i> | 1 |

- (iii) Marks awarded for this answer will be determined by the quality of communication as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

0 marks

No relevant content

Level 1 (1 – 2 marks)

A description of a method which would provide results which may not be valid

Level 2 (3 – 4 marks)

A clear description of a method enabling some valid results to be obtained. A safety factor is mentioned

Level 3 (5 – 6 marks)

A clear and detailed description of experiment. A safety factor is mentioned. Uncertainty is mentioned

examples of the physics points made in the response:

additional apparatus

- stopwatch

use of apparatus

- measure from hole to centre of the mass
- pull rule to one side, release
- time for 10 swings and repeat
- divide mean by 10
- change position of mass and repeat

fair test

- keep other factors constant
- time to same point on swing

risk assessment

- injury from sharp nail
- stand topple over
- rule hit someone

accuracy

- take more than 4 values of d
- estimate position of centre of slotted mass
- small amplitudes
- discard anomalous results
- use of fiducial marker

- (c) (i) initial reduction in T (reaching minimum value) as d increases

6

1

after 30 cm T increases for higher value of d

1

(ii) (no)

any **two** from:

- fourth reading is close to mean
- range of data 0.2 s / very small
- variation in data is expected

2

[16]