Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **May/June 2021**

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

For Examiner's Use	
1	
2	
Total	

This document has **12** pages. Any blank pages are indicated.

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

1 In this experiment, you will investigate the equilibrium of a metre rule.

(a) • Use the adhesive putty to attach the 100 g mass to the metre rule as close as possible to the 80 cm mark, as shown in Fig. 1.1.

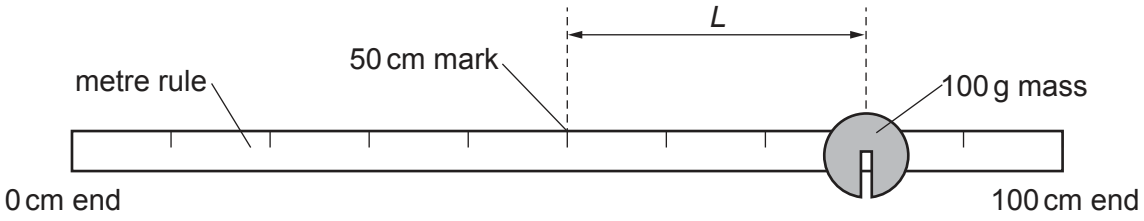


Fig. 1.1

• The distance between the 50 cm mark and the centre of the mass is *L*.

Measure and record *L*.

L = ... [1]

(b) ● Set up the apparatus as shown in Fig. 1.2.

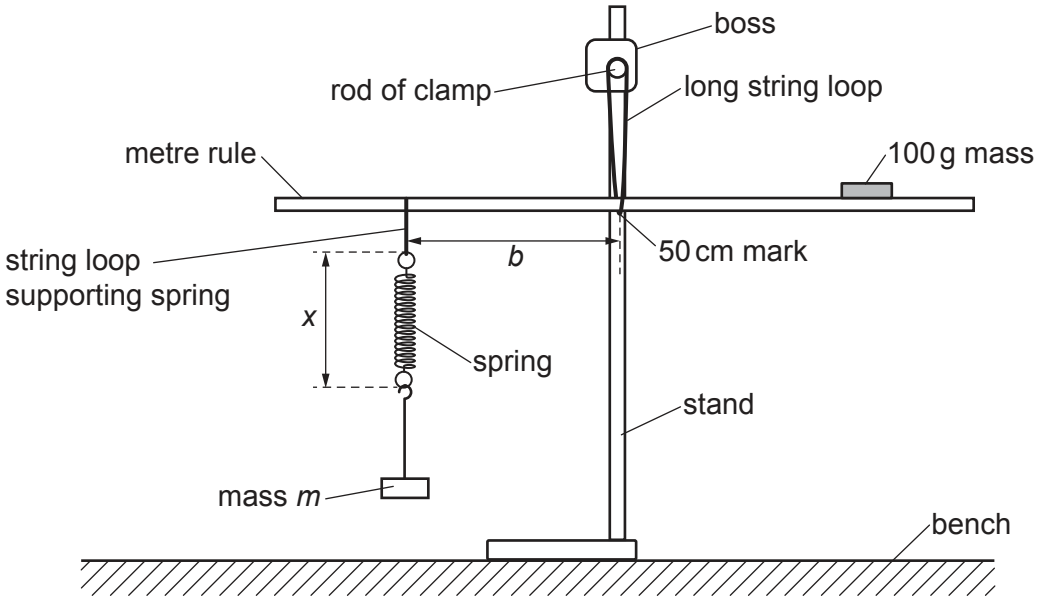


Fig. 1.2

- Suspend the rule from the long string loop at the 50 cm mark on the rule.
- Add the two 50 g masses to the mass hanger to make a total mass *m* of 110 g. Suspend mass *m* from the spring.
- Record *m*.

m = ... g

- The distance between the string loop supporting the spring and the 50 cm mark on the rule is *b*.

  The distance between the top of the top loop of the spring and the bottom of the bottom loop of the spring is *x*, as shown in Fig. 1.2.

  Adjust the position of the string loop supporting the spring until the rule is horizontal and in equilibrium.
- Measure and record *x* and *b*.

x = ...

b = ...

[1]

(c) Repeat **(b)** with different values of m until you have six sets of readings. Record m, x and b. Include your values from **(b)**.

Record your results in a table. Include values of $\frac{1}{b}$ in your table.

[9]

(d) **(i)** Plot a graph of $\frac{1}{b}$ on the y-axis against x on the x-axis. [3]

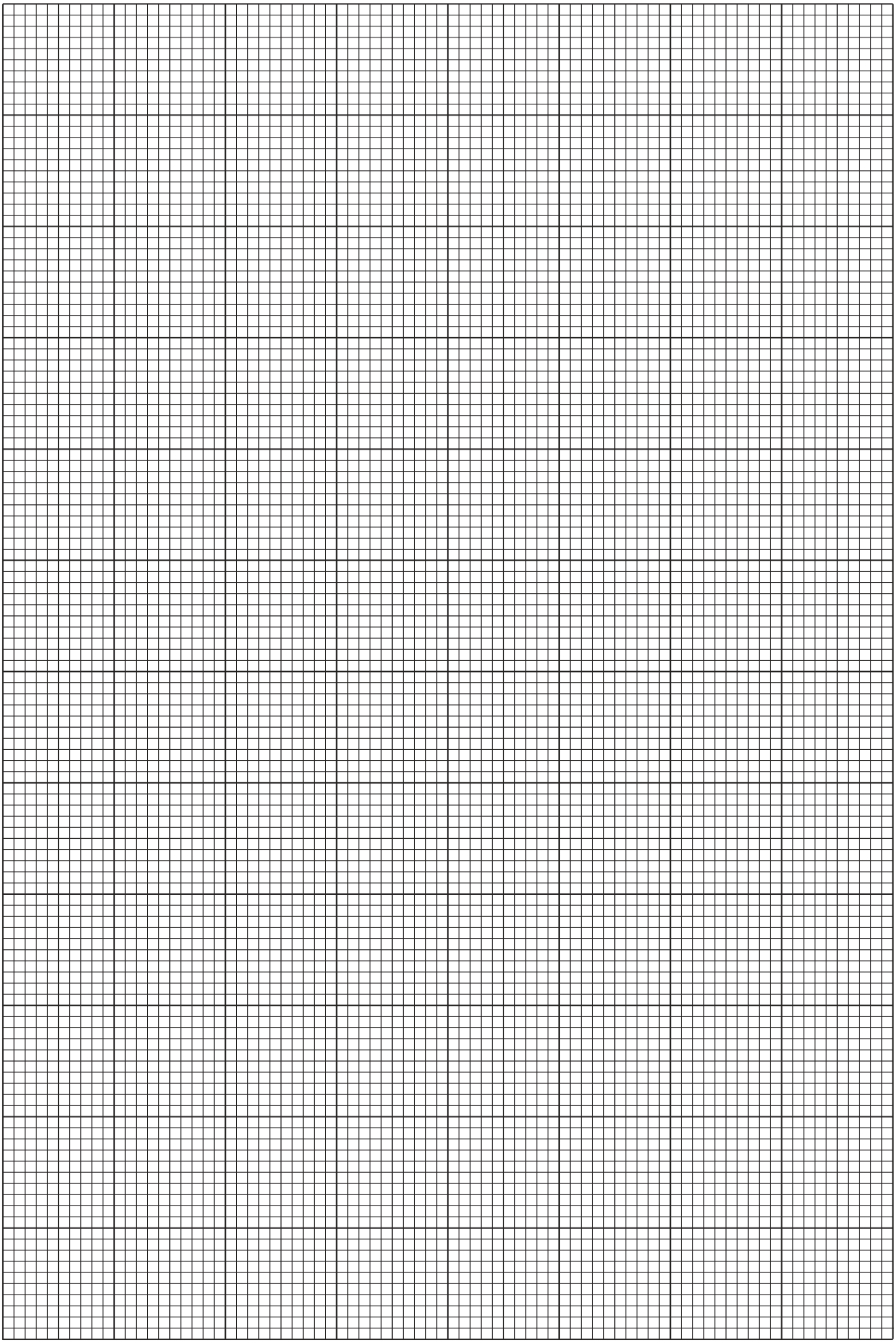
(ii) Draw the straight line of best fit. [1]

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

gradient = ...

y-intercept = ...

[2]



(e) It is suggested that the quantities b and x are related by the equation

$$\frac{1}{b} = Px + Q$$

where P and Q are constants.

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

P = ...

Q = ...
[2]

(f) A student repeats the experiment placing the 100 g mass closer to the 50 cm mark on the rule.

Theory suggests that P and Q are both inversely proportional to L.

For this experiment, draw a second line on the graph to show the expected results.
Label this line W. [1]

[Total: 20]

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

2 In this experiment, you will investigate how the rate of cooling of a hot liquid depends on its volume.

(a) You have been provided with a cup. The diameter of the base of the cup is *d*, as shown in Fig. 2.1.

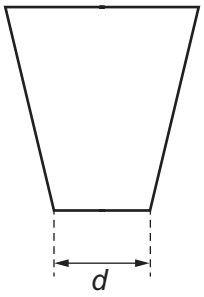


Fig. 2.1

Measure and record *d*.

d = ... [1]

(b)
- Pour boiling water into the cup until it is approximately one-third full.
- When the temperature of the water is 75 °C, start the stop-watch.

  Record this starting temperature θ_0.

  θ_0 = ... °C
- After two minutes, measure and record the temperature θ.

  θ = ... °C
- Calculate $\Delta\theta$ using

$$\Delta\theta = (\theta_0 - \theta).$$

$\Delta\theta$ = ... °C
[1]

(c) **(i)** The height of the water in the cup is h and the diameter of the surface of the water is D, as shown in Fig. 2.2.

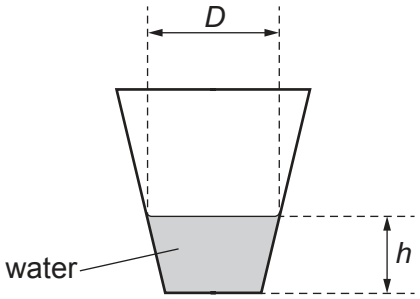


Fig. 2.2

Measure and record h and D.

h = ...

D = ...
[2]

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

percentage uncertainty = ... [1]

(iii) Calculate C where

$$C = \frac{D^3 - d^3}{D - d}.$$

C = ... [1]

(iv) Justify the number of significant figures that you have given for your value of C.

.....

.....

..... [1]

(d) ● Empty the cup.

● Repeat **(b)**, **(c)(i)** and **(c)(iii)** with the cup approximately two-thirds full.

θ_0 = ... °C

θ = ... °C

$\Delta\theta$ = ... °C

h = ...

D = ...

C = ...
[3]

[Turn over

(e) It is suggested that the relationship between $\Delta\theta$, h and C is

$$\Delta\theta = \frac{k}{\sqrt{(hC)}}$$

where k is a constant.

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

first value of k = ...

second value of k = ...
[1]

(ii) Explain whether your results support the suggested relationship.

.....

.....

.....

..... [1]

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

1. .....

.....

2. .....

.....

3. .....

.....

4. .....

.....

[4]

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

1. .....

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2. .....

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3. .....

.....

4. .....

.....

[4]

[Total: 20]

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