RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749
PAPER 4

24 AUG 2023

2 HRS 30 MIN

CANDIDATE NAME											
CENTRE NUMBER	S					**INDEX NUMBER**					
CLASS	2	2	J								

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

Candidates answer on the Question Paper.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Give details of the practical shift and laboratory where appropriate in the boxes provided.

SHIFT
LABORATORY

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINERS' USE	
1	**/ 21**
2	**/ 11**
3	**/ 11**
4	**/ 12**
TOTAL	**/ 55**

This document consists of **19** printed pages and **1** blank page.

1 In this experiment, you will investigate the equilibrium of a plastic cup.

(a) You are provided with a cup attached to a string loop. A mass M is attached to the cup as shown in Fig. 1.1. The mass M is 50 g.

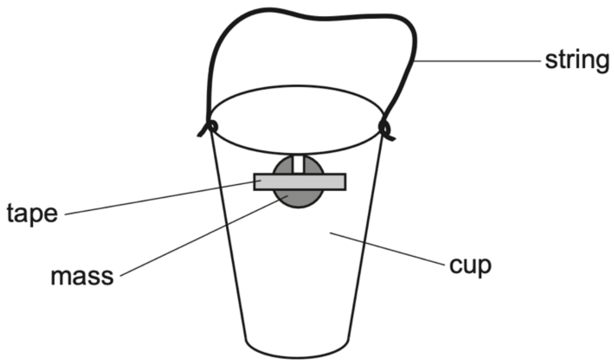

Fig. 1.1

(i) Measure and record the mass of the cup m_0.

m_0 = ………………………..

Pour approximately 25 ml of water into the cup.

Measure and record the mass of the cup with water in it, m_1.

m_1 = ………………………..

Hence determine the mass of water in the cup m.

m = ……………………….. [1]

(ii) Estimate the percentage uncertainty of m. Show your working clearly.

percentage uncertainty of m = ……………………….. [1]

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

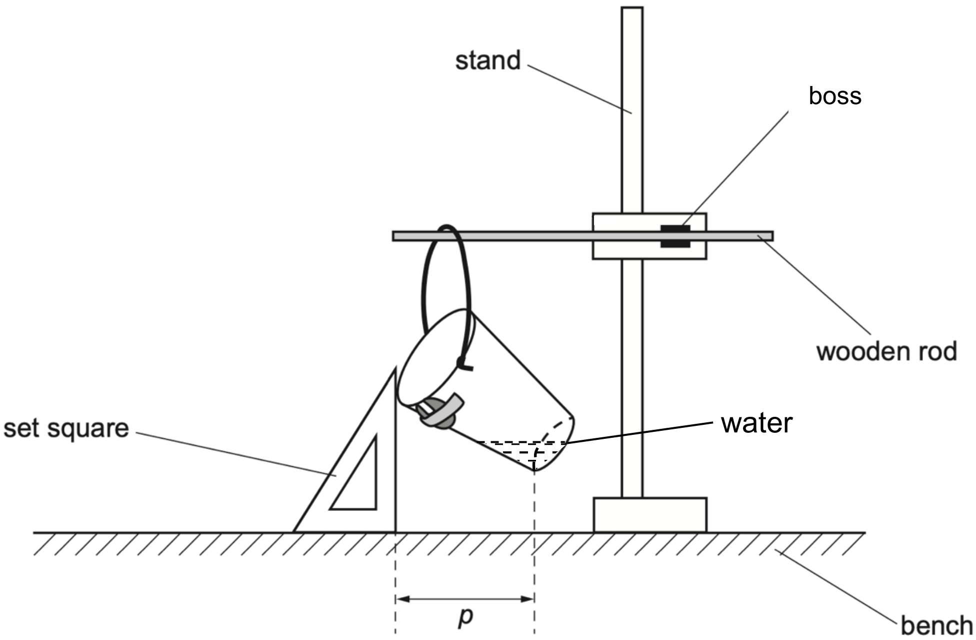

Fig. 1.2

(i) The horizontal distance between the edges of the cup is *p*, as shown in Fig. 1.2.

Measure and record *p*.

p = ……………………….. [1]

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

percentage uncertainty = ……………………….. [1]

(iii) Describe one significant source of uncertainty or limitation of the procedure in this experiment.

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.... [1]

(iv) Describe an improvement that could be made to address the uncertainty or limitation you have described in **(b)(iii)**. You may suggest the use of other apparatus or different procedures.

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.... [1]

(c) Fig. 1.3 shows the different values of *m* and *p*. Complete Fig. 1.3 using your answer from **(a)(i)** and **(b)(i)**. Include the values of $\sqrt{m}$ and $\sqrt{p}$.

m / g	*p* / cm	$\sqrt{m}$ / $g^{1/2}$	$\sqrt{p}$ / $cm^{1/2}$
34.55	6.5		
45.08	5.9		
55.14	5.0		
64.70	4.6		
74.95	3.8		

Fig. 1.3

[1]

(d) **(i)** Use Fig. 1.3 to plot the graph of $\sqrt{p}$ vs $\sqrt{m}$ in Fig. 1.4.

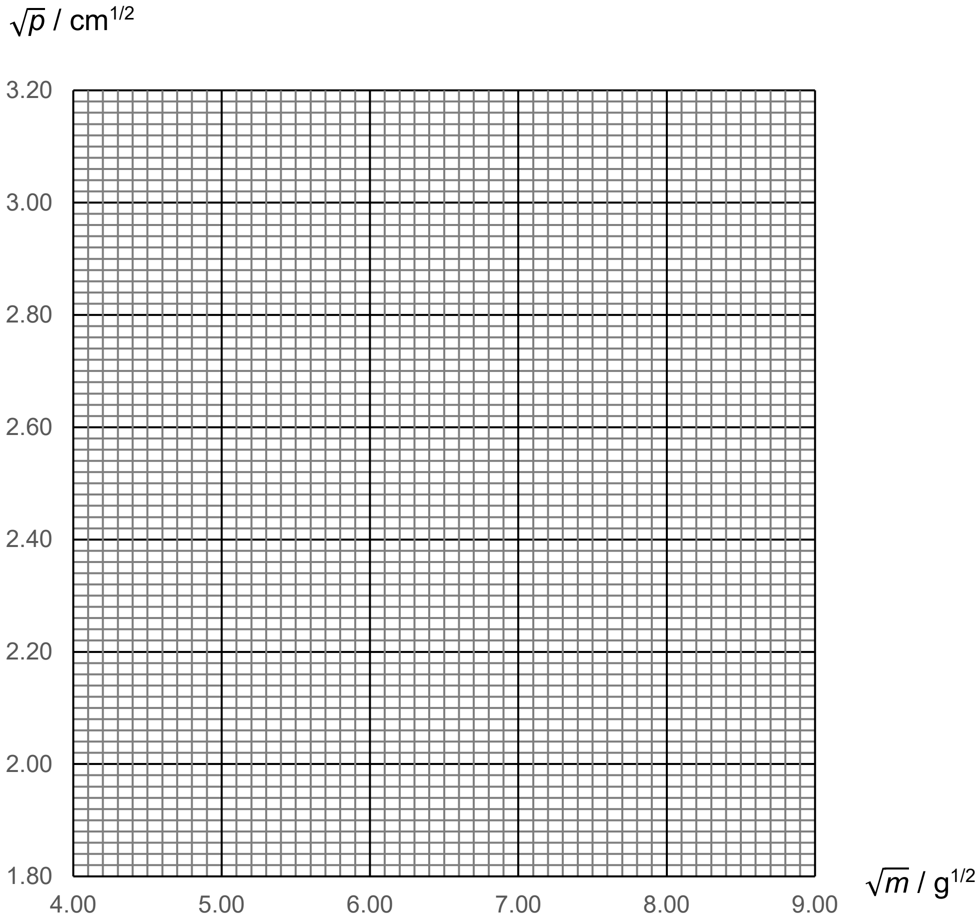

Fig. 1.4

[1]

(ii) Draw the line of best fit in Fig. 1.4. [1]

(iii) Determine the gradient and intercept of the graph in Fig. 1.4.

gradient = ………………………..

intercept = ……………………….. [2]

(iv) Use Fig. 1.4 and your answer in **(d)(iii)** to determine *p* when there is no water in the cup. Show your working clearly.

p = ……………………….. cm [2]

(e) **(i)** Empty the water you have used in **(b)** into the cup with *M* of 100 g slotted mass attached.

Repeat **(b)(i)** to obtain a new value of *p*.

p = ……………………….. cm [1]

(ii) A student suggests that $\sqrt{p}$ is directly proportional to $\sqrt{M}$.

Use your values in **(b)(i)**, **(b)(ii)** and **(e)(i)** to determine if the student's suggestion is valid. Show your working clearly.

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(f) θ is the angle of the cup above the horizontal as shown in Fig. 1.5.

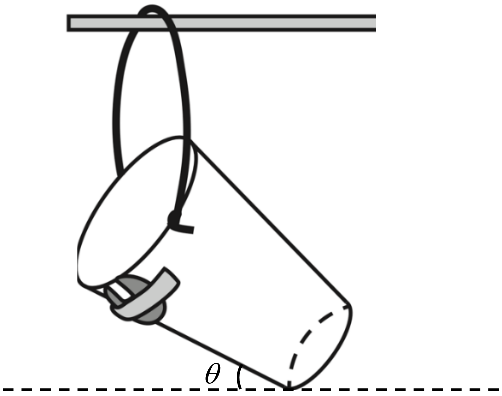

Fig. 1.5

Plan an experiment to determine accurately the mass of water in the cup m, when θ is 45°.

Also explain how you would determine the maximum value of θ for this experiment.

Your account should include:

- control of variables
- your experimental procedure
- details of the table of measurements with appropriate units

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.... [5]

[Total: 21]

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 external diameter of the base of the cup is *d* as shown in Fig. 2.1.

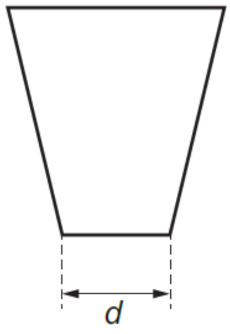

Fig. 2.1

Measure and record *d*.

d = ……………………….. [1]

(b) Setup the apparatus as shown in Fig. 2.2.

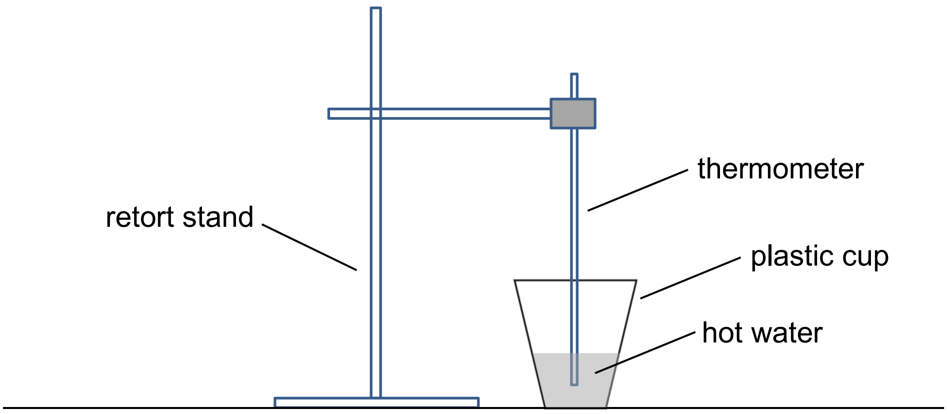

Fig. 2.2

Pour 100 ml of hot water into the cup.

When the temperature of the water θ_0 is 60.0 °C, start the stopwatch.

(i) After four minutes, measure and record the temperature θ.

θ = ……………………….. [1]

(ii) Calculate ϕ where $\phi = \theta_0 - \theta$.

ϕ = ……………………….. [1]

(iii) Estimate the absolute uncertainty in your value of ϕ.

absolute uncertainty of ϕ = ……………………….. [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. 2.3. You can assume negligible thickness of the cup and D can be measured from the exterior side of the cup.

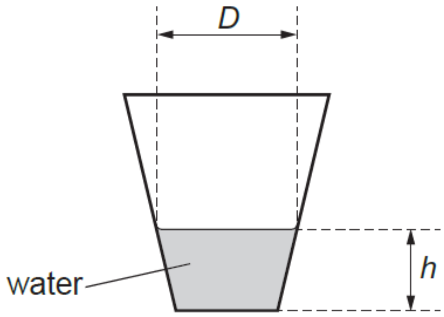

Fig. 2.3

Measure and record h and D. Be careful when handling the hot water.

h = ………………………..

D = ………………………... [1]

(ii) Calculate C where

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

C = ……………………….. [1]

(d) Empty the cup.

Repeat **(b)(i)**, **(b)(ii)** and **(c)** with 200 ml of hot water at 60.0 °C.

θ = ………………………..

ϕ = ………………………..

h = ………………………..

D = ………………………..

C = ……………………….. [2]

(e) **(i)** It is suggested that the relationship between ϕ, h and C is

$$\phi = \frac{Y}{\sqrt{hC}}$$

where Y is a constant.

Using your values in **(b)**, **(c)** and **(d)**, determine an average value of Y.

Y = ……………………….. [2]

(ii) A student suggested using a thicker cup for the experiment so that Y will be determined more accurately. He was also informed that C determined in **(c)(ii)** is related to volume of water in the cup.

Using the relationship in **(e)(i)**, explain whether you agree with the suggestion from the student.

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[Total: 11]

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3 In this experiment, you will investigate how the period of torsional oscillations of a bar magnet suspended above a fixed bar magnet changes with the separation between the two magnets.

(a) **(i)** Fix one of the magnets to the bench top using blue tack.

(ii) Tie a second magnet with strings and suspend it so that it lies in a horizontal plane about 40 cm below the point of suspension as shown in Fig. 3.1. The distance *x* between the bottom of the suspended magnet and the top of the fixed magnet should initially be about 10 cm. The base of the retort stand should be as far as possible from the fixed bar magnet.

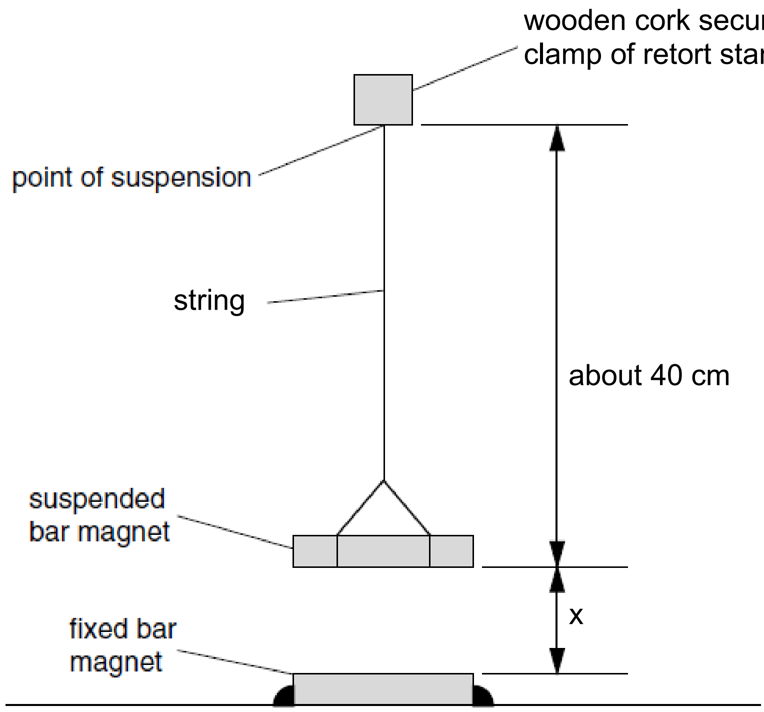

Fig. 3.1

(b) **(i)** Ensure the suspended bar magnet is at rest.

Measure and record the distance *x*. `

x = ………………………..

(ii) Gently rotate the suspended magnet and release it so that it performs small torsional oscillations in a horizontal plane as shown in Fig. 3.2.

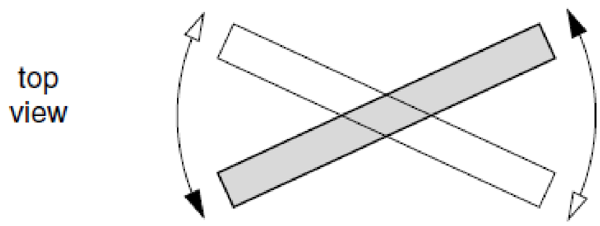

Fig. 3.2

Determine the period *T* of these oscillations.

T = ……………………….. [1]

(iii) Change the value of *x* and repeat **(b)(i)** and **(b)(ii)** until you have six sets of readings for *T* and *x* where 8 cm ≤ *x* ≤ 12 cm.

[4]

(c) It is suggested that *T* and x are related by an expression of the form

$$1 = P\frac{x}{T} + \frac{Q}{T}$$

where *P* and *Q* are constants.

Plot a suitable graph to determine *P* and *Q*.

P = ………………………..

Q = ……………………….. [5]

(d) Suggest whether it is possible to measure directly the period of oscillation of the suspended magnet for a separation x = 2 cm.

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[Total: 11]

4 When light is incident on the front of a photocell, an e.m.f. V is generated in the photocell.

A student wishes to investigate the effects of varying the number n of identical thin glass sheets and varying the thickness t of one sheet, in front of a photocell. This may be carried out in the laboratory using a light source and a photocell.

It is suggested that V is related to n and t by the equation

$$V = V_0 \, e^{-\alpha n t}$$

where V_0 is the e.m.f. generated without any glass sheet.

Design a laboratory experiment to investigate the effects of n and t on V. You are provided with a filament light bulb, photocell and several glass sheets of different thickness, and have access to standard laboratory apparatus. You should draw a diagram showing the arrangement of your equipment. In your account you should pay particular attention to

- the procedure to be followed,
- the measurements to be taken,
- the control of variables,
- how to determine absorption coefficient of glass α,
- and any precautions that should be taken to improve the safety and accuracy of the experiment.

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