HWA CHONG INSTITUTION
C2 Preliminary Examination
Higher 2

A

CANDIDATE NAME		CT GROUP	**22S**
CENTRE NUMBER		INDEX NUMBER	

PHYSICS **9749/04**

Paper 4 Practical

21 August 2023

2 hours 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

You will be allowed a maximum of one hour to work with the apparatus for Questions 1 and 2, and a maximum of one hour for Question 3. You are advised to spend approximately 30 minutes on Question 4.

Write your answers in the spaces provided 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.

At the end of the examination, submit sets A, B and C separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	**/ 10**
2	**/ 11**
3	**/ 21**
4	**/ 12**
Total	**/ 54**

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1 In this experiment, you will investigate the centre of gravity of a suspended card shape.

(a) You have been provided with a card shape, as shown in Fig. 1.1.

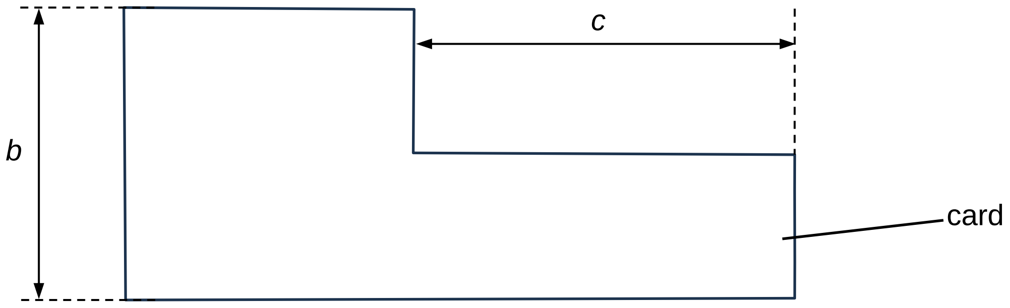

Fig. 1.1

Measure and record the lengths *b* and *c*.

b = ……………………………………………………

c = ……………………………………………………

[1]

(b) Use the pin to make two small holes in the card, as shown in Fig. 1.2.

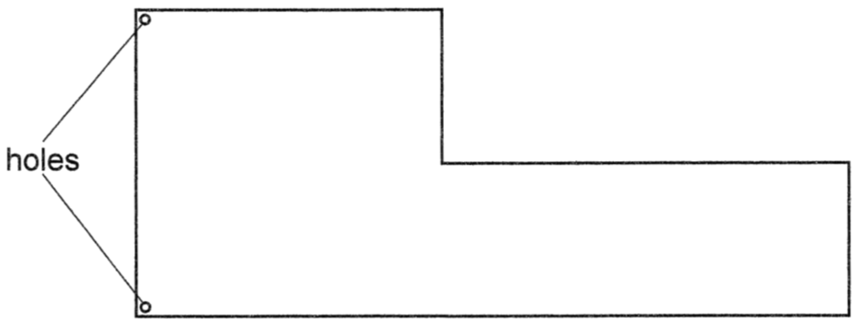

Fig. 1.2

Suspend the card as shown in Fig. 1.3. The pin should be held firmly in the clamp and the card should hang freely. The loop of string at the end of the pendulum should be attached to the pin.

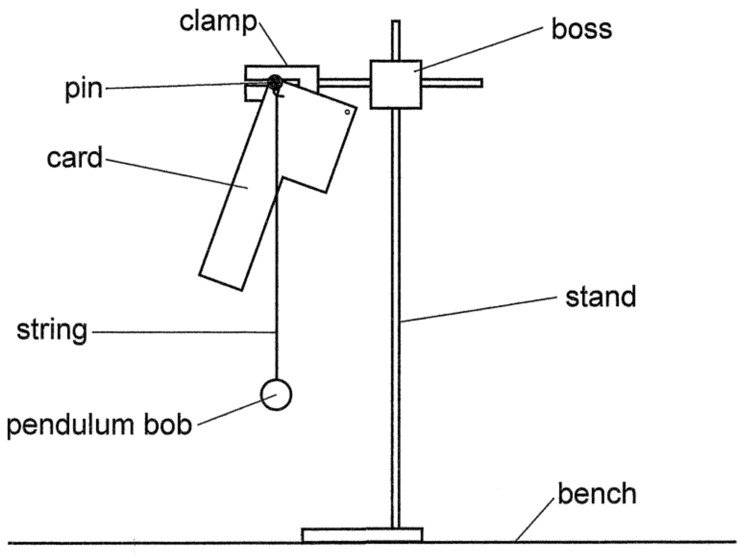

Fig. 1.3

Use the pencil to draw a line on the card along the path of the string in Fig. 1.3, as shown in Fig. 1.4.

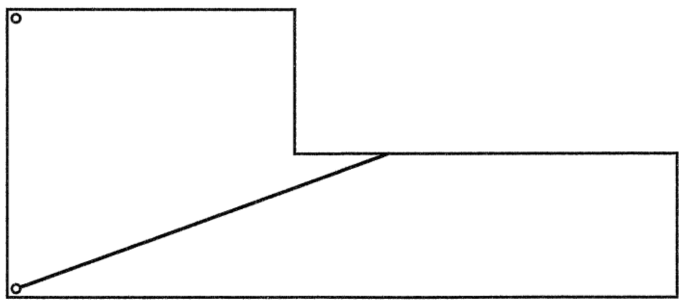

Fig. 1.4

Repeat the procedure using the other hole in the card. The two lines will cross at the centre of gravity G, a distance *y* above the longest edge of the card, as shown in Fig. 1.5.

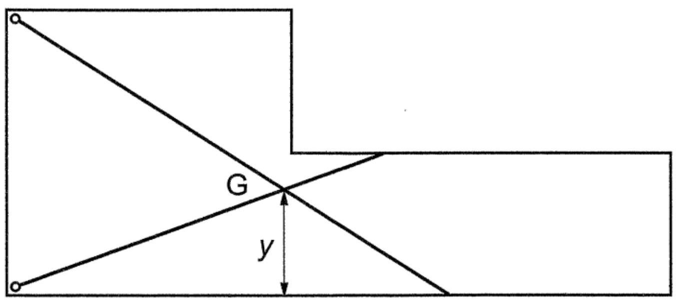

Fig. 1.5

Measure and record *y*.

y = ... [2]

(c) **(i)** Reduce c by 6 cm by cutting the card at right-angles to its longest edge.

Measure and record c.

c = ... [1]

(ii) Repeat the procedure from page 4.

y = ... [1]

(d) Theory suggests that

$$y = \frac{\frac{b^2}{2} + \frac{bc}{8}}{b + \frac{c}{2}}$$

where b remains constant.

(i) Calculate the value of y when c is reduced by another 6 cm.

y = ... [1]

(ii) The experiment is repeated for more values of c.

State the graph to plot to obtain a straight line assuming that the theory is correct.

....

....

.... [1]

(iii) State expressions for the gradient and y-intercept of the line.

gradient = ...

y-intercept = ...

[2]

(e) Explain, without calculation, why the value of y is equal to 6 cm when $c = 0$.

....

....

.... [1]

Total: [10]

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

(a) Set up the circuit shown in Fig. 2.1.

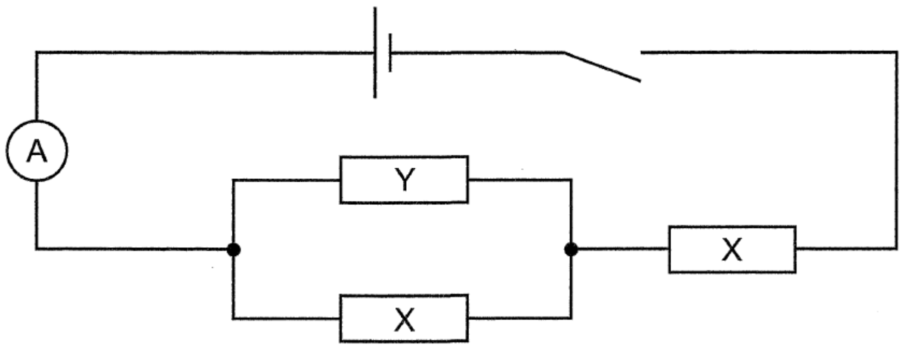

Fig. 2.1

The value of the resistance of Y is R_Y. Its value should be $10\,\Omega$.
Record R_Y.

R_Y = ...

Close the switch.

Measure and record the ammeter reading I_1.

I_1 = ...

Open the switch.

Change the positions of the resistors Y and X, as shown in Fig. 2.2.

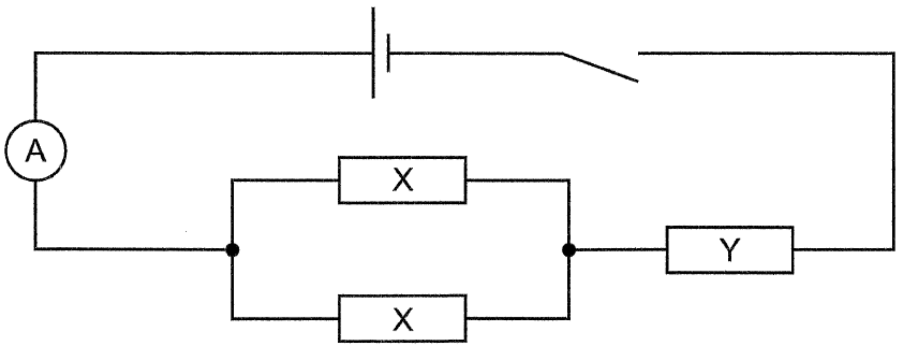

Fig. 2.2

Close the switch.

Measure and record the ammeter reading I_2.

I_2 = ...
[1]

Open the switch.

(b) Vary R_Y and repeat **(a)**.
Present your results clearly.

[3]

(c) I_1, I_2 and R_Y are related by the expression

$$\frac{I_1}{I_2} = \frac{R_Y}{2R_X} + \frac{1}{2}$$

where R_X is the resistance of resistor X.

Plot a graph and use the gradient to determine R_X.

R_X = ...

[5]

(d) By considering the value of $\frac{I_1}{I_2}$ when $R_Y = R_X$, describe another way in which the graph can be used to determine R_X.

……...

……...

…….. [1]

(e) The experiment is repeated with a larger value of R_X.

Sketch a line on your graph grid on page 9 to show the expected result.

Label this line W.

[1]

[Total: 11]

NAME ______________________ CLASS 22S ( ) SCORE ______ **B**

3 In this experiment, you will model the stability of a scoop of ice cream in a cone.

(a) **(i)** Measure and record the diameter *x* and the height *h* of the cone, as shown in Fig. 3.1.

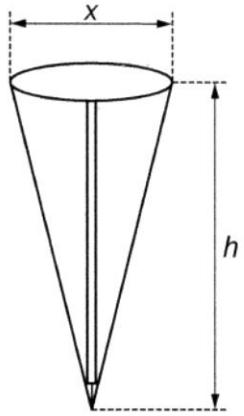

Fig. 3.1

x = ……………………………………………

h = ……………………………………………

[1]

(ii) Estimate the percentage uncertainty in your value of *x*.

percentage uncertainty = …………………………% [1]

(b) **(i)** Place the ping-pong ball in the cone, as shown in Fig. 3.2.

Tilt the cone until the ping-pong ball falls out, as shown in Fig. 3.3.
The angle between the bench and the **centre** line of the cone is θ.
The height of the top of the centre line above the bench is y.

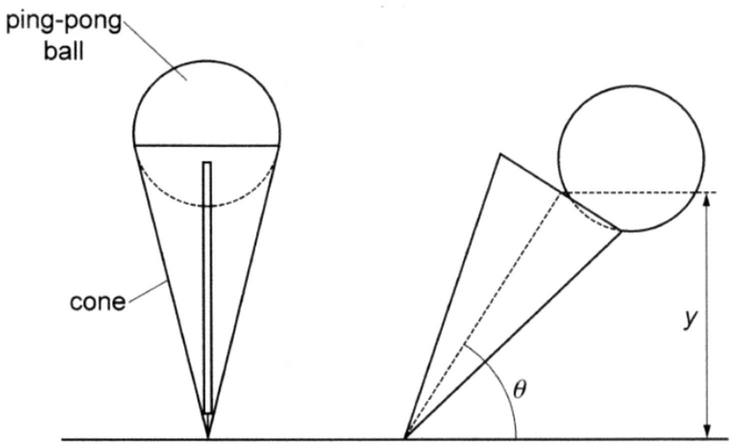

Fig. 3.2 **Fig. 3.3**

Measure and record θ and y.

θ = ……………………………..

y = ……………………………..
[2]

(ii) Calculate tan θ.

tan θ = ………………………….. [1]

(c) **(i)** You have been provided with a sheet of paper with the outline of another cone.

Cut around the outline and assemble this cone.

(ii) Repeat **(a)(i)** and **(b)**.

x = ……………………………..

h = ……………………………..

θ = ……………………………..

y = ……………………………..

tan θ = …………………………..
[2]

(d) It is suggested that $\tan\theta = \dfrac{ky}{hx}$, where *k* is a constant.

(i) Use your values from **(a)(i)**, **(b)** and **(c)(ii)** to determine two values for *k*. Give your values for *k* to an appropriate number of significant figures.

first value for *k* = ……………………………………...

second value for *k* = ……………………………………..

[1]

(ii) State whether the results of your experiment support the suggested relationship.

Justify your conclusion by referring to your value in **(a)(ii)**.

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………………………………………………………………………………………………….. [1]

(e) **(i)** Suggest **two** significant sources of error in this experiment.

1 ....

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2 ....

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[2]

(ii) Suggest an improvement that could be made to the experiment to address one of the errors identified in **(e)(i)**. You may suggest the use of other apparatus or a different procedure.

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.... [1]

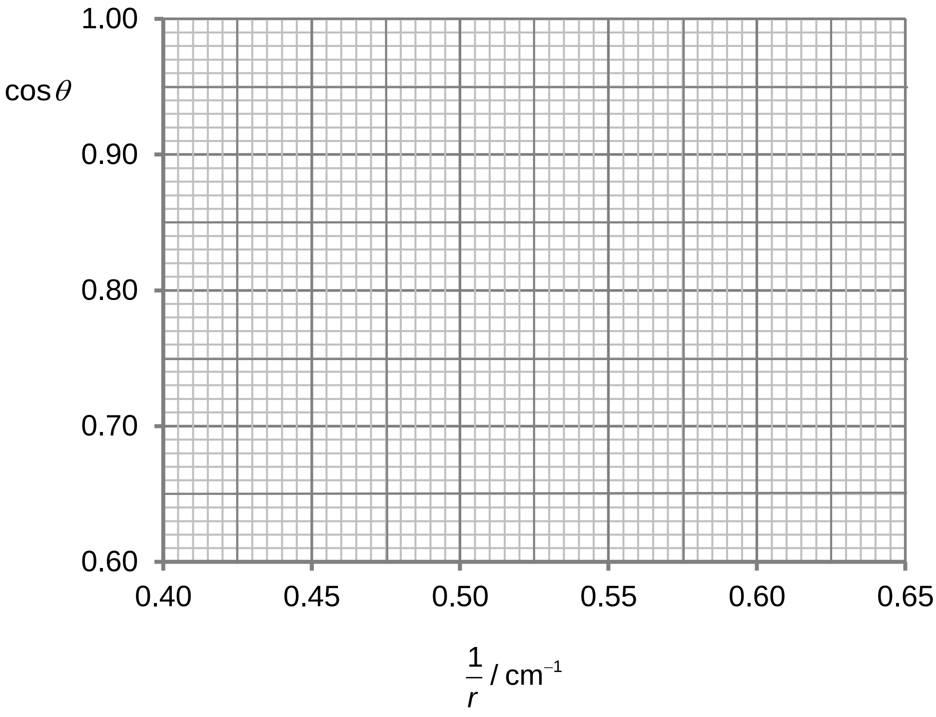
(f) The experiment is repeated using a cone with fixed dimensions and spheres of different radii *r*.

The results are shown in the table.

Values of $\frac{1}{r}$ and cos θ are included.

r / cm	$\frac{1}{r}$ / cm^{-1}	θ / °	cosθ
1.6	0.63	20	0.94
1.8	0.56	34	0.83
2.0	0.50	41	0.75
2.2	0.45	47	0.68
2.4	0.42	51	0.63

(i) Plot the points on the grid and draw the straight line of best fit.



[1]

(ii) Determine the *y*-intercept of the line.

y-intercept = ………………………. [2]

(iii) Use your answer in **(f)(ii)** to state whether cos θ is inversely proportional to r.

……………………………………………………………………………………………………

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……………………………………………………………………………………………………

…………………………………………………………………………………………….. [1]

(g) An ice-cream cone manufacturer uses cones of height 10 cm and diameter 6 cm. These are used for ice-cream scoops which are the same size as tennis balls.

They wish to reduce the height of the cones, but the scoop must still be stable when θ = 60°.

Plan an investigation to find the minimum height of a cone that they could make.

Your account should include:

- your experimental procedure
- details of the table of measurements with appropriate units
- how you would find the minimum height.

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[Total: 21]

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NAME ______________________ CLASS 22S ( ) SCORE _______ **C**

4 Fig. 4.1 shows an electric fan powered by a simple thermoelectric generator.

A temperature difference across the thermoelectric material generates an electromotive force (e.m.f.).

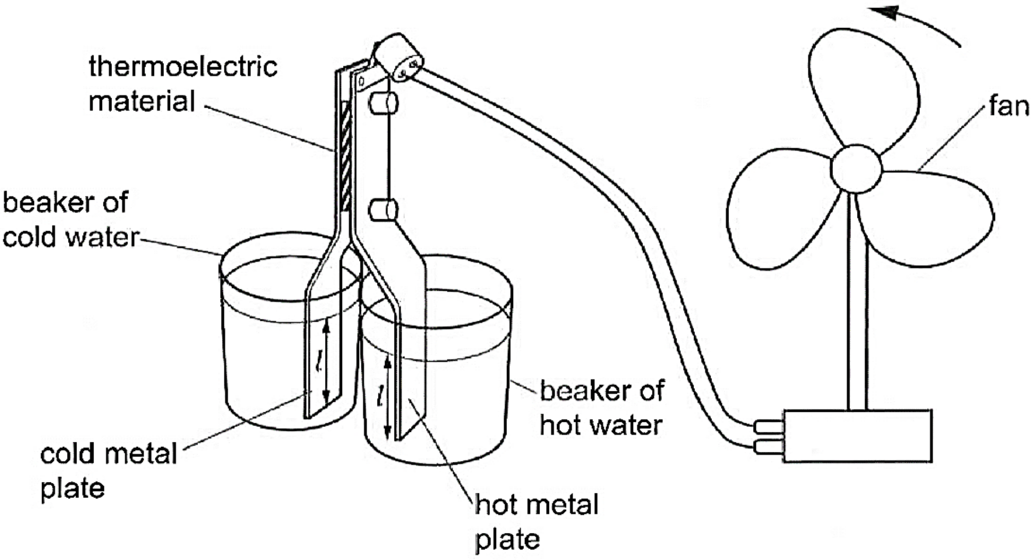

Fig. 4.1

The e.m.f. ε depends on the temperature difference θ between the hot and cold metal plates and the length l of the metal plates in the water.

The e.m.f. ε is given by:

$$\varepsilon = k\theta^{\alpha} l^{\beta}$$

where *k*, α and β are constants.

Design an experiment to determine the values of α and β.

Draw a diagram to show the arrangement of your apparatus. You should pay particular attention to:

- the equipment you would use
- the procedure to be followed
- the control of variables
- any precautions that should be taken to improve the accuracy and safety of the experiment.

Diagram

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[Total: 12]