Name: _____ ( ) Class: 21 / _____

ANDERSON SERANGOON JUNIOR COLLEGE

2021 JC2 Preliminary Exam

PHYSICS Higher 2 9749/04

Paper 4 Practical **30 Aug 2021**

2 hours 30 minutes

Candidates answer on the Question Paper.
Additional Materials: As listed in the Confidential Instructions

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READ THESE INSTRUCTIONS FIRST

Write your name, class index number and class in the spaces provided above.
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.

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, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
Paper 4 (55 marks)	
1	
2	
3	
4	
Total (55 marks)	

For Examiner's Use

Question 1 begins on the next page.

For Examiner's Use

1 In this experiment, you will investigate how the resistance R of a thermistor varies with its temperature θ.

(a) Construct the circuit shown in Fig. 1.1.

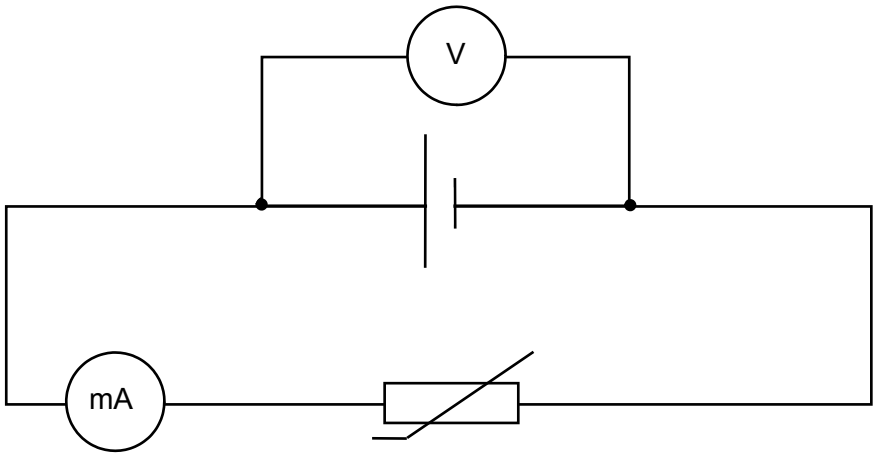

Fig. 1.1

(b) Immerse the thermistor in a beaker of water. Measure and record the current I, potential difference V and temperature θ.

I = ...

V = ...

θ = …….....[1]

M1

(c) **(i)** Arrange the apparatus so that the water may be heated. **Use the stand and clamp to ensure that the wires connected to the thermistor are kept well away from the source of heating.**

(ii) Use the heating apparatus to raise the temperature of the water by about 10 ^{0}C.

After the temperature has stabilized, measure and record the new values of I, V and θ.

I = ...

V = ...

θ = …….....

For Examiner's Use

(iii) Repeat **(c)(ii)** for θ varying from room temperature to 80 °C.

Tabulate these results. Include the results from **(b)**, **(c)(ii),** all the values of R, where $R = V / I$, and all the values of thermodynamic temperature T, where $T = \theta + 273$.

[6]

(d) The formula which relates R and T is

$$R = Ae^{\frac{E}{kT}}$$

where A is a constant, E is an energy characteristic of the thermistor, and $k = 1.38 \times 10^{-23}$ J K^{-1}.

Plot a suitable graph to determine values for E and A.

A2	
A3	
A4	
A5	

E = ……..……..

A = ……..……

[7]

For Examiner's Use

P4	
P5	
P6	

(e) Comment on any anomalous data or results you may have obtained. Explain your answer.

For Examiner's Use

……..……

……..……

……..……*[1]*

M3

[Total: 15 marks]

P4

P5

P6

For Examiner's Use

Question 2 begins on the next page.

2 In this experiment, you will investigate the oscillations of a pendulum.

For Examiner's Use

(a) Set up the apparatus as shown in Fig. 2.1. The length l of the pendulum is approximately 70 cm. As the pendulum oscillates, a stop shortens the effective length l by an amount d.

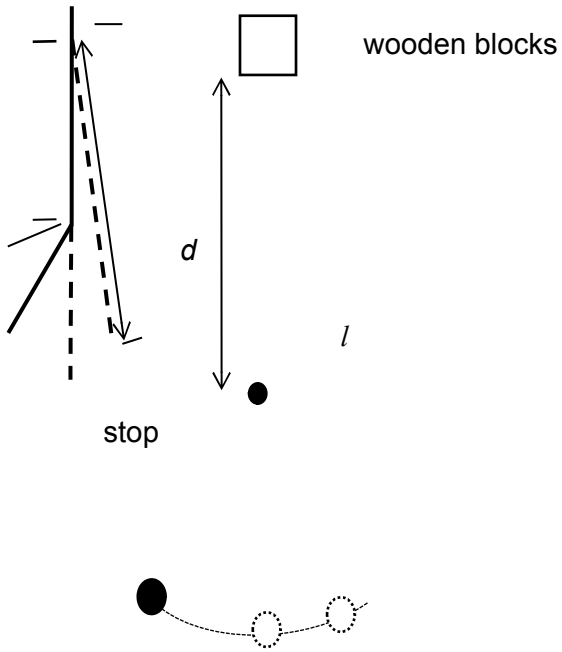

Fig. 2.1

Mount the wooden rod horizontally so that it acts as a stop half-way down the pendulum. The stop should *just touch* the string when the pendulum rests in a vertical plane.

(b) **(i)** Measure and record the value of l.

l = ……..……..……..

(ii) Measure and record the value of d.

d = ……..……..…… [1]

M1	

(iii) Gently displace the pendulum so that it performs small oscillations in a vertical plane perpendicular to the stop.

Make and record measurements to determine the period T of these oscillations.

M2	
A1	

T = ……..…….…… [2]

For Examiner's Use

(c) The quantities d and T are related by the equation

$$T = -\frac{\pi^2}{k}\left(\frac{d}{T}\right) + 2\pi\sqrt{\frac{l}{g}}$$

where k and l are constants, and g = 9.81 m s $^{-2}$.

(i) Calculate k.

k = …….…….. m s^{-2}

[2]

A2	
A3	

(ii) It is not accurate to draw a conclusion for the value of k based on only one reading as in **c(i)**. It is a good practice to determine k graphically.

Using the same apparatus, describe how you would obtain further measurements, and the graph that you would plot to determine k.

…….

…….

…….

…….

…….

…….[2]

A4	
A5	

[Total: 7 marks]

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

For Examiner's Use

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

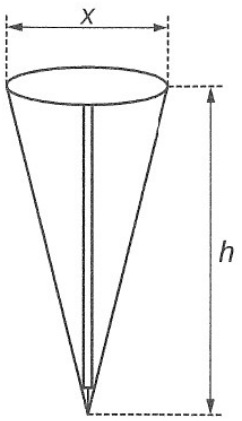

Fig. 3.1

x = ……

h = ……[1] M1

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

percentage uncertainty = ……% [1] A1

(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.

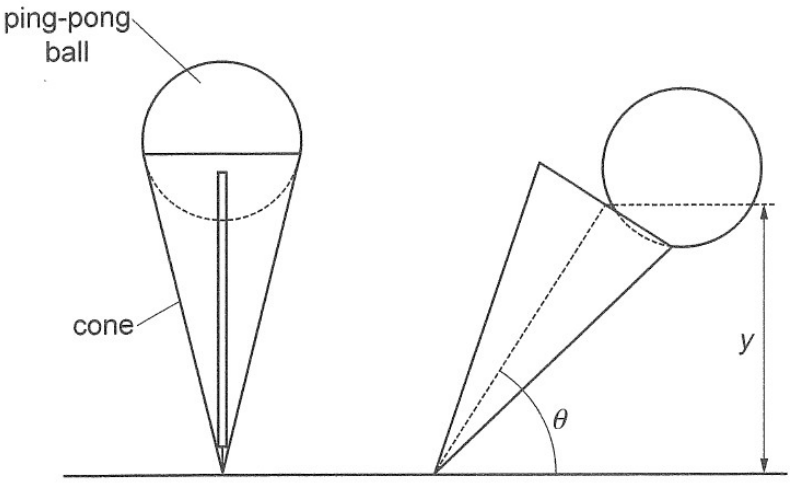

Fig. 3.2 **Fig. 3.3**

Measure and record θ and y.

θ = ...

y = ... [2]

M2	
M3	

(ii) Calculate tan θ.

tan θ = ... [1]

A2	

For Examiner's Use

(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)**.

For Examiner's Use

x = ...

h = ...

θ = ...

y = ...

$\tan\theta$ = ... [2]

M4 M5

(d) It is suggested that $\tan\theta = \frac{ky}{hx}$ 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]

A3

(ii) State whether the results of your experiment support the suggested relationship. Justify your conclusion by referring to your value in **(a)(ii)**.

For A4

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…… [1] A4

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

1 ……

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2 ……

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…… [2] A5

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

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……[1] A6

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

For Examiner's Use

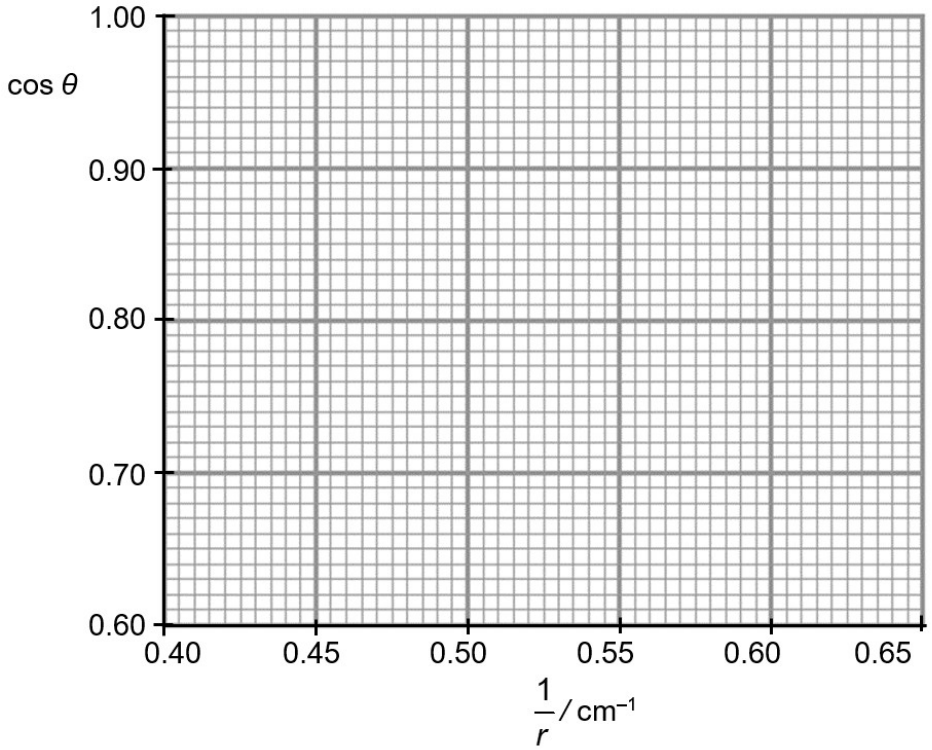
radii *r*.

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/ °	cos θ
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]

P1

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

A7
A8

y-intercept = ... [2]

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

A7
A8

For Examiner's

A9

A9

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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 $\theta = 60^{\circ}$.

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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……[5]

[Total: 21 marks]

PL1

PL2

PL3

PL4

PL5

PL1

PL2

PL3

PL4

4 The motion of a small cube on a turntable connected to an electric motor is shown in Fig. 4.1.

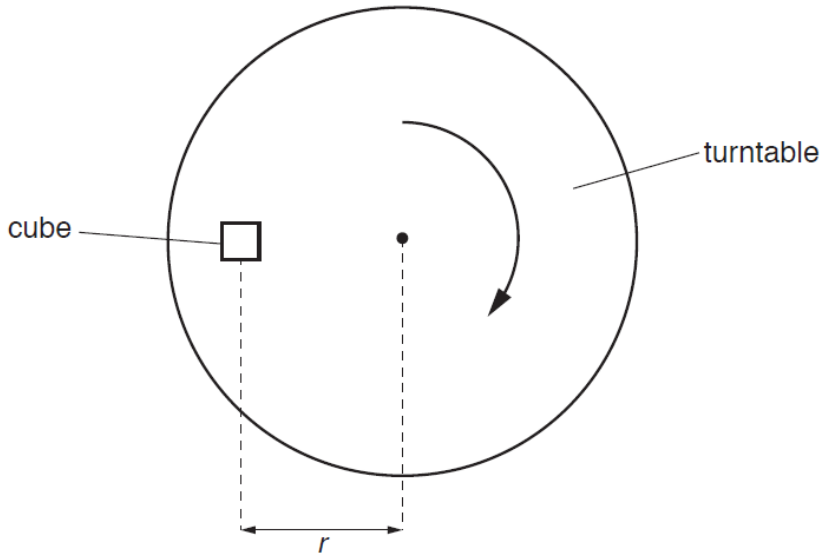

Fig. 4.1

The cube is placed at a distance r from the centre of the turntable. A student suggested that the maximum frequency f of the turntable for which the cube does not move relative to the turntable depends on r and mass m of the cube.

The relation between f, r and m may be written in the form

$$f = Kr^p m^q$$

where K, p and q are constants.

You are provided with a number of cubes of different sizes of the same material.
Design an experiment to determine the values of K, p and q.

Draw a diagram to show the arrangement of your apparatus. Pay particular attention to

(a) the equipment you would use
(b) the procedure to be followed
(c) how you would vary the frequency of the turntable
(d) the control of variables
(e) any precautions that should be taken to improve the accuracy and safety of the experiment.

Diagram

For Examiner's Use

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For Examiner's Use

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[Total: 12 marks]

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