YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CG		INDEX NO	

PHYSICS 9749/04

Paper 4 Practical **26 Aug 2021**

2 hours 30 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class 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, highlighters, glue or correction fluid/tape.

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, where appropriate, in the boxes provided.

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	
1	**/16**
2	**/ 6**
3	**/21**
4	**/12**
Total	**/55**

This document consists of **17** printed pages and **3** blank pages.

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

You are provided with several groups of resistors connected in parallel.

(a) Assemble the circuit as shown in Fig. 1.1

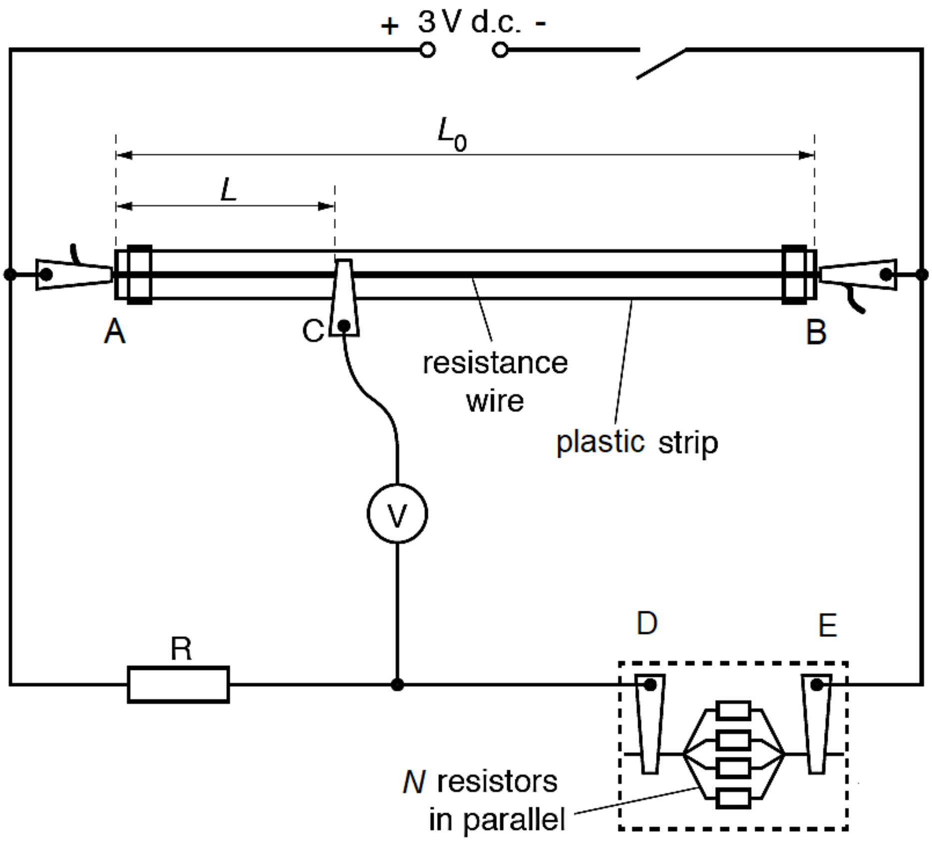

Fig. 1.1

A, B, C, D and E are crocodile clips.

Measure and record the length L_o of the resistance wire between the ends of A and B, as shown in Fig. 1.1.

L_o = ... [1]

(b) **(i)** Select from the groups of resistors connected in parallel, N=4 and connect it across D and E as shown in Fig.1.1.

(ii) Close the switch. Move C along the wire until the voltmeter reading is zero.

Measure and record the distance L between A and C when the voltmeter reading is zero, as shown in Fig. 1.1.

L = ... [1]

Open the switch.

(c) Select a different group of resistors and repeat **(b)(ii)** until you have at least six sets of values of *N* and *L*.

Record your results in a table.

Include values of $\frac{1}{N}$ and $\frac{1}{L}$ in your table of results.

[6]

(d) **(i)** It is suggested that the quantities *L* and *N* are related by the equation

$$\frac{1}{L} = \frac{a}{N} + b$$

where *a* and *b* are constants.

Plot a suitable graph to determine *a* and *b*. Give appropriate units.

a = ………………………...

b = ……………………….

[7]

(e) Without taking further readings, sketch a line on your graph grid to show the results you would expect if the experiment was repeated with the wire across AB replaced by one with the same length but with a larger resistance per unit length.

Label this line W. [1]

[Total : 16]

2 In this experiment, you will investigate the oscillatory motion of a loaded metre rule supported at one end by a spring.

(a) Secure the cork in the clamp so that the pin is mounted horizontally. Suspend one end of the rule from the pin by passing the pin through the hole in the rule. The rule should be able to pivot around the pin.

The other end of the metre rule has a spring attached to it through a small loop of string at the 0.5 cm mark. Hook the other end of the spring to the rod of another clamp as shown in Fig. 2.1.

The clamps should be adjusted so that the rule is approximately horizontal.

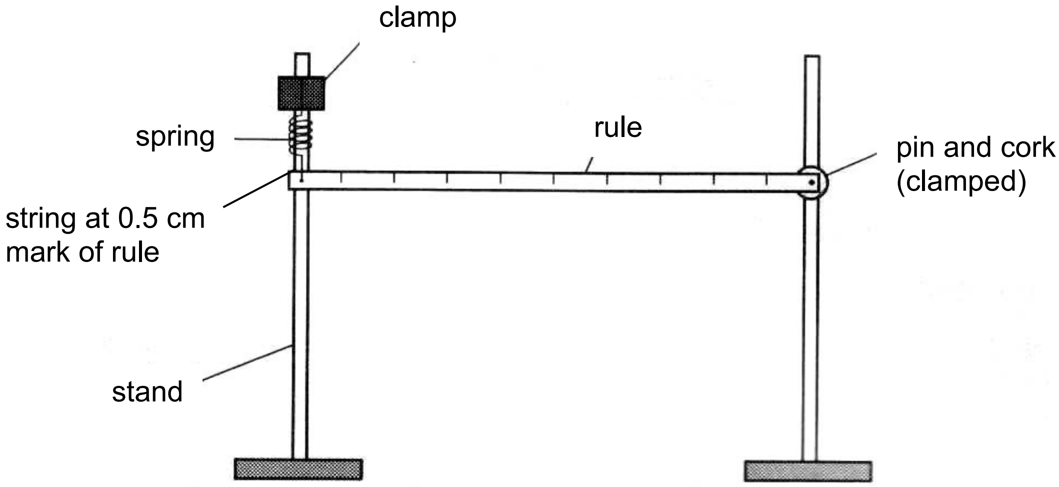

Fig. 2.1

(b) Hang the loop of string onto the rule to suspend a mass of 350 g a distance *d* from the pin as shown in Fig 2.2. The mass should be about halfway along the rule. Adjust the position of the clamps to make the rule approximately horizontal again.

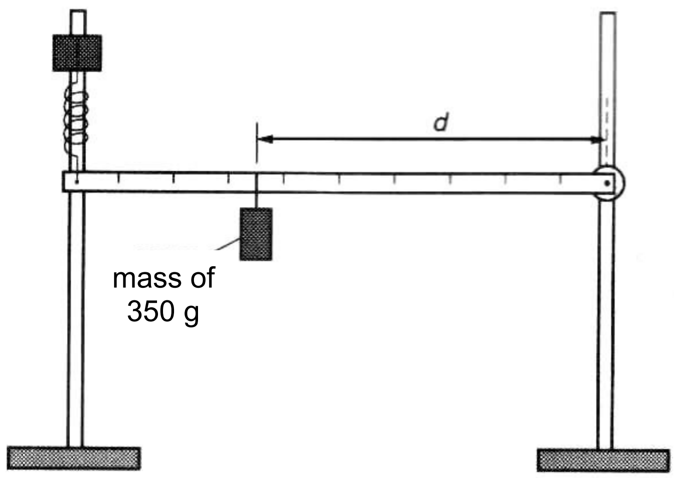

Fig. 2.2

(c) **(i)** Based on the scale on the metre rule, record the position of the loop attached to the hanging mass, X_A.

Record the position of the pin, X_B.

X_A = ……………………………........

X_B = ……………………………........

[1]

(ii) Determine d.

d = ……………………........ [1]

(d) Gently displace the end of the rule so that it performs small oscillations in a vertical plane.

Determine the period T of the oscillations.

T = ……………………........ [2]

(e) The equation that relates T and d for this oscillator is

$$T^2 = \frac{4\pi^2}{kL^2}(Md^2 + C)$$

where k is 28.0 N m^{-1}, M is the mass of the load, L is 1.000 m and C is a constant.

Calculate C.

C = ……………………........ [2]

[Total: 6]

3 In this experiment, you will investigate the magnetic field produced by an electric current.

You are provided with two sets of a wire coiled around a plastic channel. One set is longer than the other.

Choose the **longer** plastic channel and set it on the raised board as shown in Fig. 3.1.

(The raised board placed on a pair of wooden blocks is necessary to reduce the effects of the magnetic materials under the table top.)

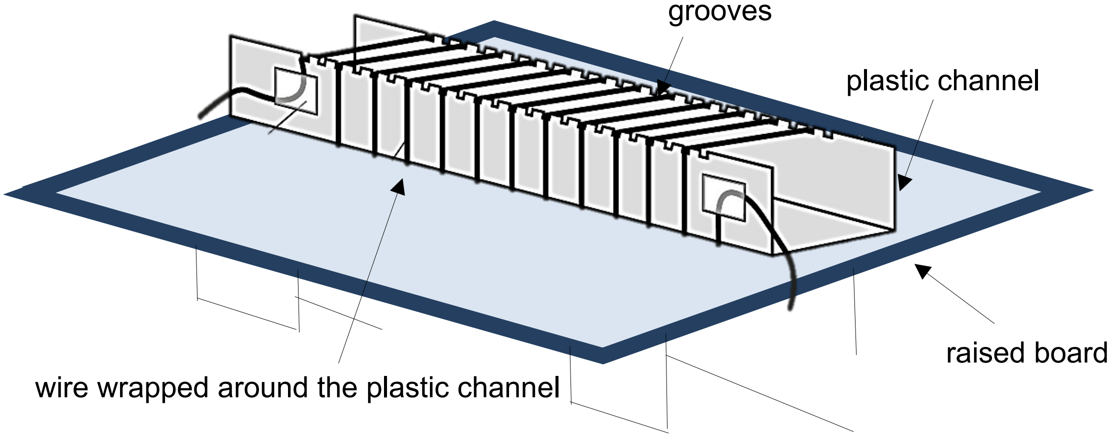

Fig. 3.1

(a) Count and record the number of **complete** turns N of wire in the coil.

N = ...

(b) Slide the compass into the plastic channel so that it lies flat on the red circle in the middle of the coil. The coil is to be placed on the raised board.

Connect the circuit as shown in Fig. 3.2.

Rotate the plastic channel until the arrow of the compass is perpendicular to the channel, as shown in Fig. 3.2.

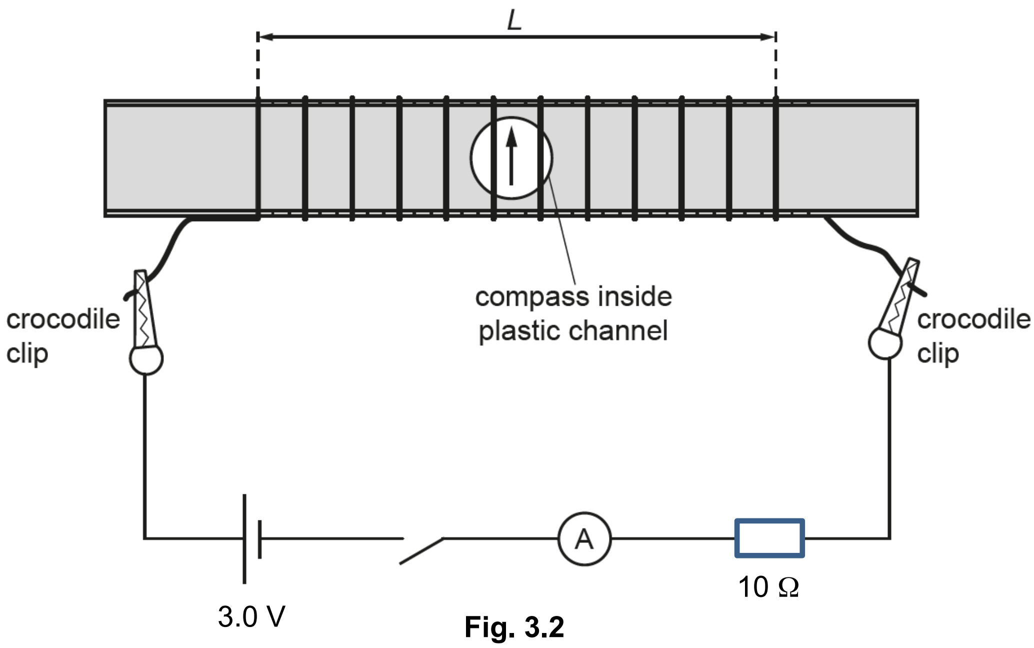

Fig. 3.2

The distance between the first and last turns of wire is L, as shown in Fig.3.2.

Measure and record L.

L = ………………………… [1]

(c) Close the switch. The compass arrow will rotate through an angle θ.

Measure and record θ.

θ = …………………………^{o}

Record the ammeter reading I.

I = …………………………..

[2]

Open the switch.

(d) **(i)** Estimate the percentage uncertainty in your value of θ.

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

(ii) Suggest one significant source of uncertainty in this experiment.

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

(iii) Suggest an improvement that could be made to the experiment to reduce the uncertainty identified in **(d)(ii)**.

You may suggest the use of other apparatus or a different procedure.

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

(e) Calculate the value of B using

$$B = \frac{\mu_o N I}{L}$$

where $\mu_o = 1.26 \times 10^{-6}$ N A^{-2}.

B = …………………… N A^{-1} m^{-1} [1]

(f) Disconnect the crocodile clips and remove the compass.

Place the compass inside the middle of the **shorter** plastic channel as shown in Fig.3.3.

Reattach the crocodile clips.

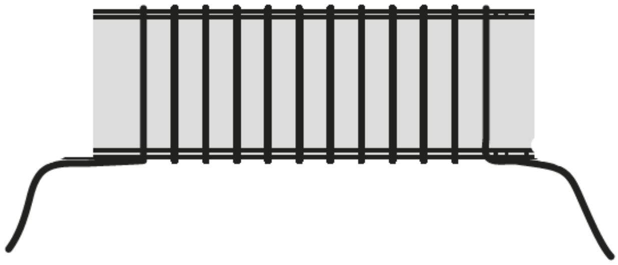

Fig. 3.3

Repeat steps **(a)**, **(b)**, **(c)** and **(e)**.

N = …………………………

L = …………………………

θ = …………………………^{o}

I = …………………………

B = …………………… N A^{-1} m^{-1}

[3]

(g) It is suggested that the relationship between θ and B is

$$\tan\theta = \frac{B}{k}$$

where k is a constant.

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

first value of k = ……………………………………..

second value of k = ……………………………………..

[1]

(ii) Justify the number of significant figures you have given for your values of k.

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

(iii) State whether the results of your experiment support the suggested relationship. Justify your conclusion by referring to your answers in **(d)(i)**.

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(h) In an investigation, the compass is inserted into a certain plastic channel where the relation between the angle of deflection θ and the current ***I*** in the wire is related by the equation.

$$\tan\theta = \frac{\mu_o n I}{B_E}$$

where

$\mu_o = 1.26 \times 10^{-6}$ N A^{-2}

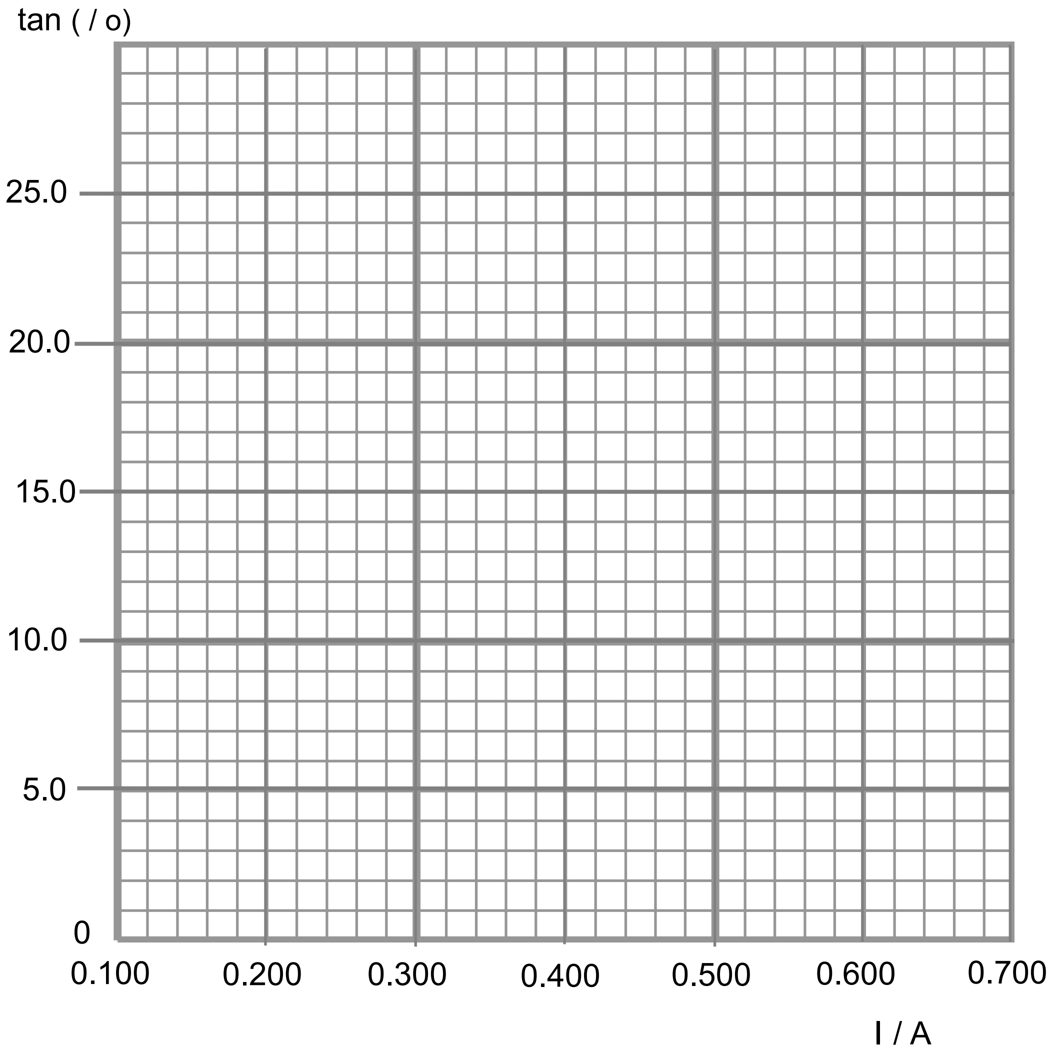
n = number of turns per unit length = 1200 per metre.

B_E = the horizontal component of the Earth's magnetic flux density.

The following results for I and $\tan\theta$ were recorded.

I / A	0.156	0.209	0.357	0.572	0.648
tan (θ / °)	6.37	8.54	14.6	23.4	26.5

(i) Plot $\tan\theta$ against ***I*** on the grid and draw the straight line of best fit. [1]



(ii) Use your graph to determine the value of B_E, the horizontal component of the Earth's magnetic flux density.

B_E = ……….………………… N A^{-1} m^{-1} [3]

(i) The experiment in **(h)** is repeated. Instead of using a magnetic compass to determine the magnetic flux density at the centre of the current carrying solenoid, a Hall probe is to be used.

Plan an investigation using the same set of apparatus to verify the relationship between the magnetic flux density B at the centre of the solenoid and the current I in the solenoid given as

$$B = \mu_o nI$$

where n is the number of turns per unit length along the solenoid.

Your account should include:

- your experimental procedure (with a circuit diagram)
- managing the controlled variables
- details of how the Hall probe is used
- how the above relation is verified

You may suggest the use of any additional apparatus commonly found in a school physics laboratory.

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.... [4]

[Total: 21]

4 A student wishes to investigate the surface texture of a new coating material.

The material is spray coated onto the surface of a circular disk and attached to the axle of a motor at its centre. A small object is then placed onto the disk at a distance *r* from the centre and the motor is started to rotate the disk about its centre as shown in Fig. 4.1.

When the static friction between the surface of the coating and the object is exceeded, the object is observed to start slipping off the coated surface. This happens when the maximum angular speed, ω, of the disc is reached before slippage is observed.

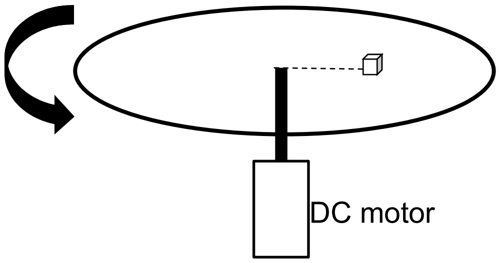

Fig. 4.1

The student suggested that the relationship between the maximum angular speed of the disc, ω, the mass of the object, *m*, and its distance from the centre of the disc, *r*, may be expressed in the form

$$\omega = A m^x r^y$$

where *A*, *x* and *y* are constants.

You are provided with a DC motor and a controller to adjust the rotational speed of the motor. You may also use any of other equipment usually found in a physics laboratory.

Design an experiment to determine the values of *x* and *y*.

Draw a diagram showing the arrangement of your apparatus. In your account you should pay particular attention to

(a) the identification and control of variables,

(b) the equipment you would use and measurements to be taken,

(c) the procedure to be followed,

(d) how you would determine the maximum angular speed, ω, of the disc,

(e) the analysis of the data,

(f) any precautions that would be taken to improve the accuracy and safety of the experiment.

Diagram

[Turn over

[Total: 12]

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