SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION
SECONDARY FOUR

CANDIDATE NAME	

CLASS	4			REGISTER NUMBER		

PHYSICS

6091/03

Paper 3

30 July 2025

1 hour 50 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Give details of the practical shift and laboratory in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction tape.

Answer **all** questions in the spaces provided on the Question Paper: scrap paper must not be used. Graph paper is provided in this Question Paper.

You will be allowed to work with the apparatus for a maximum of 55 minutes for each section.

You are expected to record all your observations as soon as they are made.
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.

At the end of the practical, 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	**/ 10**
2	**/ 10**
3	**/ 20**
Total	**/ 40**

BLANK PAGE

1 *In this experiment, you will investigate the force needed to pull a cylinder up a step.*

You are provided with:

- a half-metre rule
- a digital caliper
- a newton meter
- two 100 g slotted masses
- a loop of thread

(a) Measure and record the thickness *h* of the half-metre rule, as shown in Fig. 1.1.

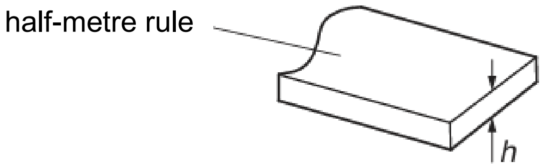


Fig. 1.1

h = ... [1]

(b) (i) Suspend the two slotted masses from the newton meter using the loop of thread as shown in Fig. 1.2.

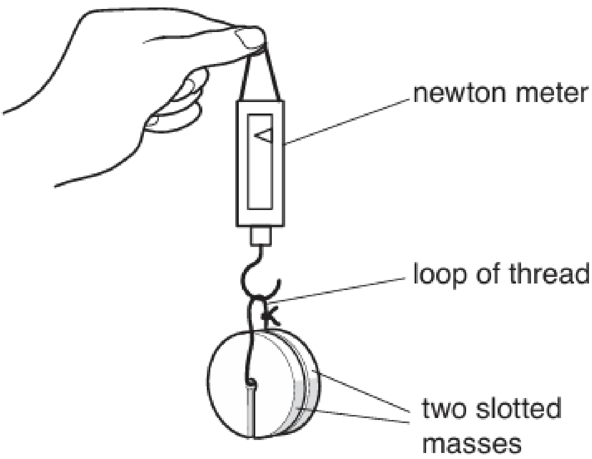


Fig. 1.2

(ii) Measure and record the total weight *W* of these masses.

W = ... [1]

(c) Measure and record the diameter d of one of the slotted masses. Determine the radius r of this slotted mass.

d = ...

r = ... [1]

(d) **(i)** Place the half-metre rule on the bench. Stand two slotted masses on their edges next to one end of the rule, with their slots at the top, as shown in Fig. 1.3. Attach the loop of thread to the masses and the newton meter, as shown in Fig. 1.3.

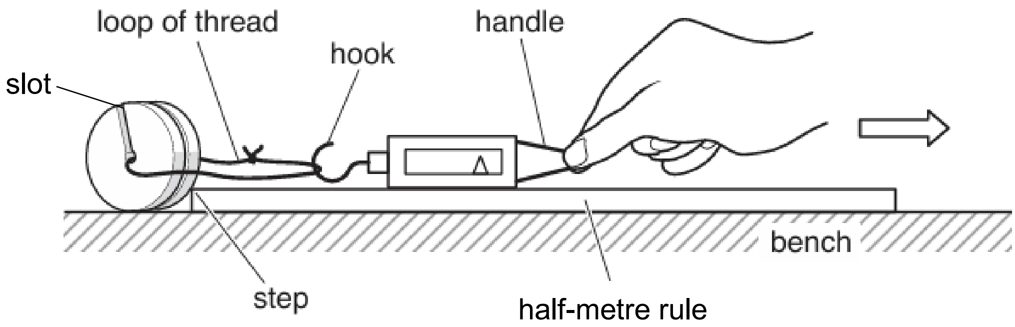


Fig. 1.3

Pull the handle of the newton meter horizontally and at right angles to the step. The force required to just start the slotted masses rolling up the step is F. Measure and record F.

F = ... [1]

(ii) Determine the angle α, given by

$$\sin \alpha = \frac{(r - h)}{r}$$

α = ... [1]

Plan

It is suggested that F, W and α are related by the equation

$$F = \frac{kW}{\tan \alpha}$$

where k is a constant.

You are to plan an experiment to investigate the above relationship.

You can also use other apparatus and materials that are usually available in a school laboratory.

Your plan should include:
- the independent and dependent variables,
- the quantities that you will be keeping constant in the investigation,
- a detailed description of how you will perform the investigation,
- an indication of how you will achieve accurate results,
- explanation on how to use the readings to reach the conclusion.

A diagram is not required but you may draw one if it helps in your explanation.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

……….

……….

……….

……….

……….

……….

……….

……….

……….

……….

……….

……….

……….

……[5]

[Total : 10 m]

2 *In this experiment, you will determine the focal length of a semicircular block using two methods.*

You are provided with

- a transparent semicircular block
- a protractor
- a half-metre rule
- a digital caliper
- a piece of paper labelled P
- a corkboard
- 3 optical pins

METHOD 1

(a) Take measurements to determine the radius of curvature R of the curved surface, as shown in Fig. 2.1.

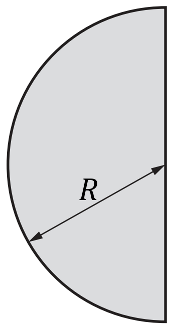


Fig. 2.1

R = ... [1]

(b) **(i)** A piece of paper labelled P, with four parallel lines drawn on it, is provided.

Measure and record lengths A and B.

A = ...

B = ...

Calculate E using $$E = \frac{B}{A}$$

E = ... [1]

(ii) Arrange the apparatus as shown in Fig. 2.2.

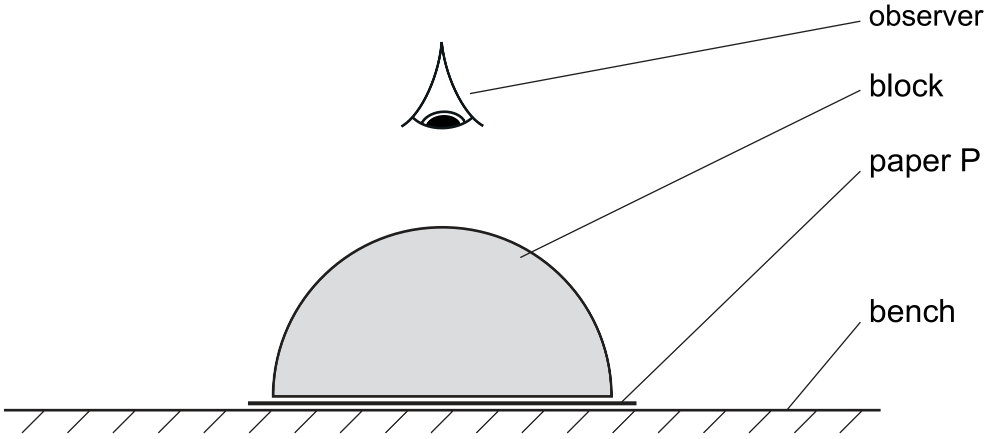


Fig. 2.2

Look down through the block and close one eye. The appearance of the lines should be similar to Fig. 2.3.

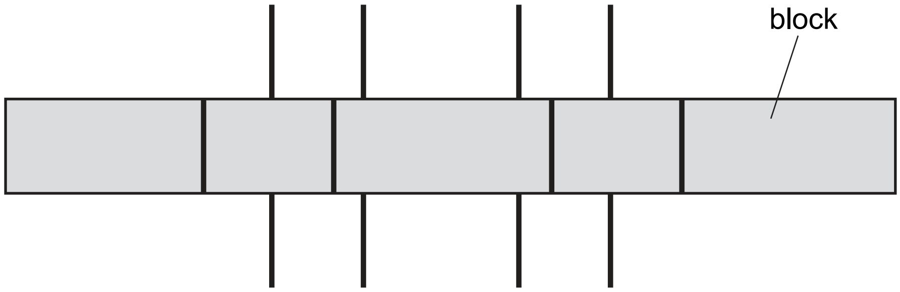


Fig. 2.3

Gradually raise the block until the two central lines seen through the block are aligned with the two outer lines seen outside the block, as shown in Fig. 2.4.

You may have to move your head sideways to see this alignment.

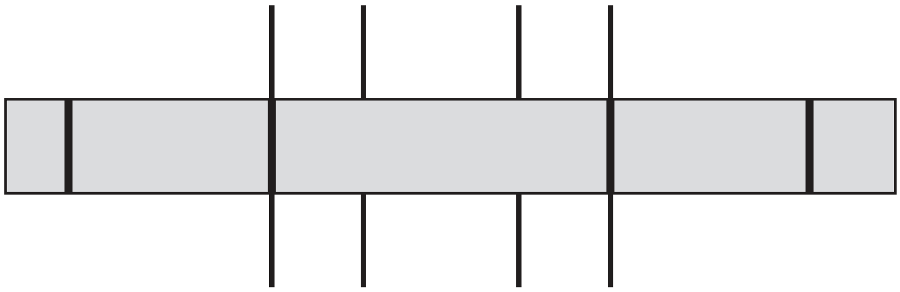


Fig. 2.4

With the block in this position, measure and record the height d_1 of the block above the paper, as shown in Fig. 2.5.

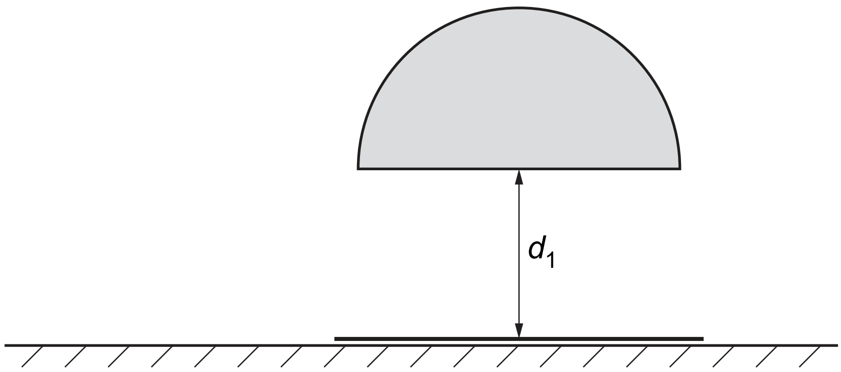


Fig. 2.5

d_1 = ... cm [1]

(iii) Turn the block over and place the curved face onto the paper. Look down through the block with one eye. Gradually raise the block until the two central lines seen through the block are aligned with the two outer lines seen outside the block.

Measure and record the height d_2 of the block above the paper, as shown in Fig. 2.6.

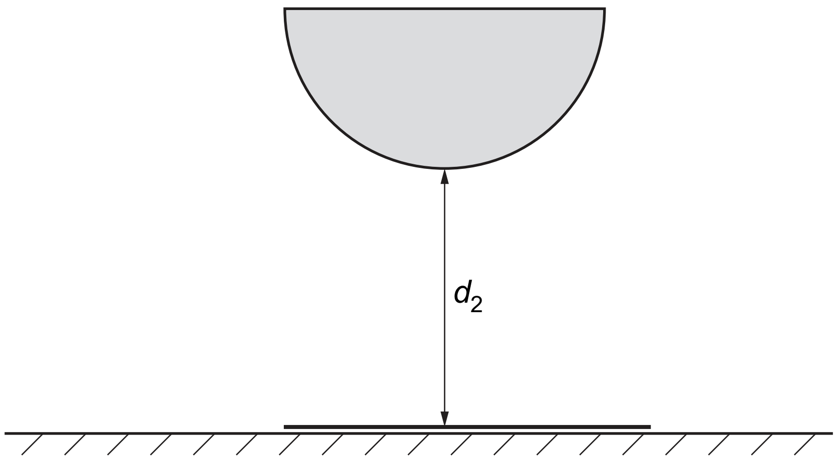


Fig. 2.6

d_2 = ... cm [1]

(c) It is suggested that the relationship between R, d_1 and d_2 is

$$2k = R + d_1 - d_2$$

where k is a constant.

Using your data, calculate k. Give the appropriate unit.

k = ... [1]

(d) The focal length f of the block is given by

$$f = \frac{E(d_2 + k)}{(E - 1)}$$

Calculate the value of f. Give the appropriate unit.

f = ... [1]

METHOD 2

(e) **(i)** You are given an A4 paper with two lines labelled **AB** and **CD** (refer to page 13). Place the semicircular block on **AB** such that the centre of the block coincides with the point **O,** as shown in Fig 2.7. Trace the outline of the block on the paper.

(ii) Draw a line **OM** from **O** to the circumference of the block such that the angle made by this line with **AB**, θ, is 60°.

(iii) By placing two pins **P1** and **P2** on the line **OM**, view the two pins through the straight edge of the glass block. Shift your line of vision slowly until a position is reached when the two pins appear in a straight line.

(iv) Using a third pin **P3**, locate and mark this position on the paper.

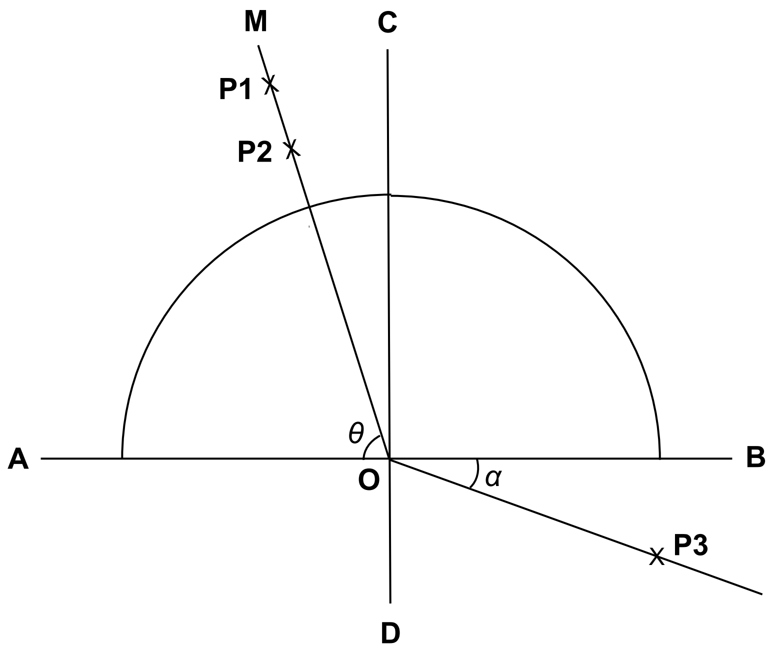


Fig. 2.7 (not to scale)

(v) Draw a line joining **P3** to **O**. Measure and record α, the angle made by this line with the line **AB**, as shown in Fig. 2.7.

α = ... [1]

(f) The refractive index of the glass block, n_{glass}, is given by the equation

$$n_{glass} = \frac{\cos \alpha}{\cos \theta}$$

Determine the refractive index of the glass.

n_{glass} = ... [1]

(g) It was theorised that the focal length, *f*, of the semicircular glass block is given by

$$\frac{1}{f} = (n_{\text{glass}} - 1)\left(\frac{1}{R}\right)$$

Calculate the focal length *f* of the semicircular glass block.

f = ……………………………… [1]

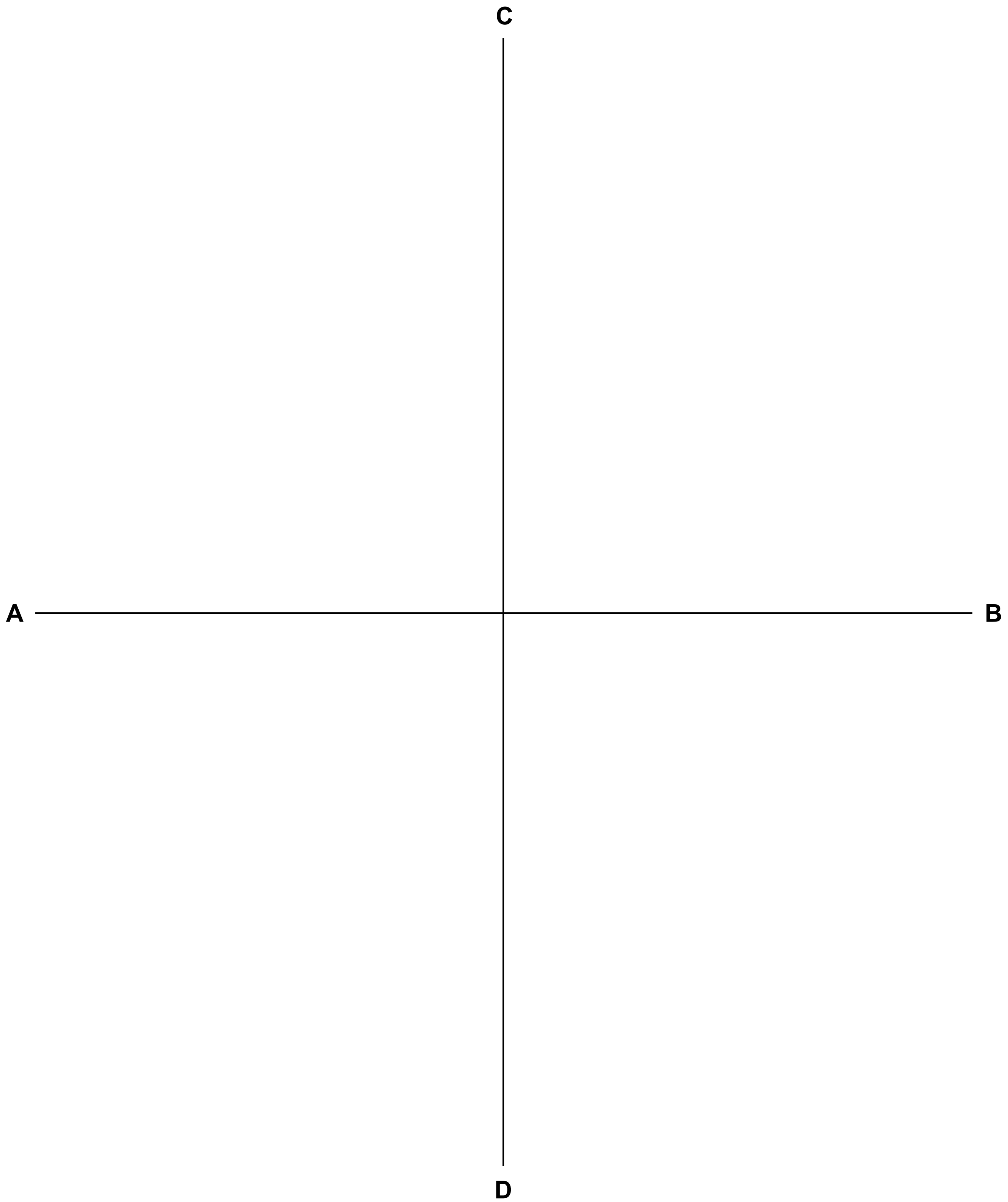
(h) Describe one improvement that could be made to the two methods. You may suggest the use of other apparatus or different procedures.

……

……

……[1]

[Total : 10 m]


C
A
B
D

BLANK PAGE

3 *In this experiment, you will investigate an electrical circuit.*

You are provided with

- a power supply
- a switch
- an unknown resistor Y
- a wire mounted on a wooden board with a metre rule
- connecting leads
- a voltmeter
- an ammeter

(a) Measure and record E, the electromotive force (e.m.f.) of the power supply.

E = ... [1]

(b) Set up the circuit as shown in Fig. 3.1.

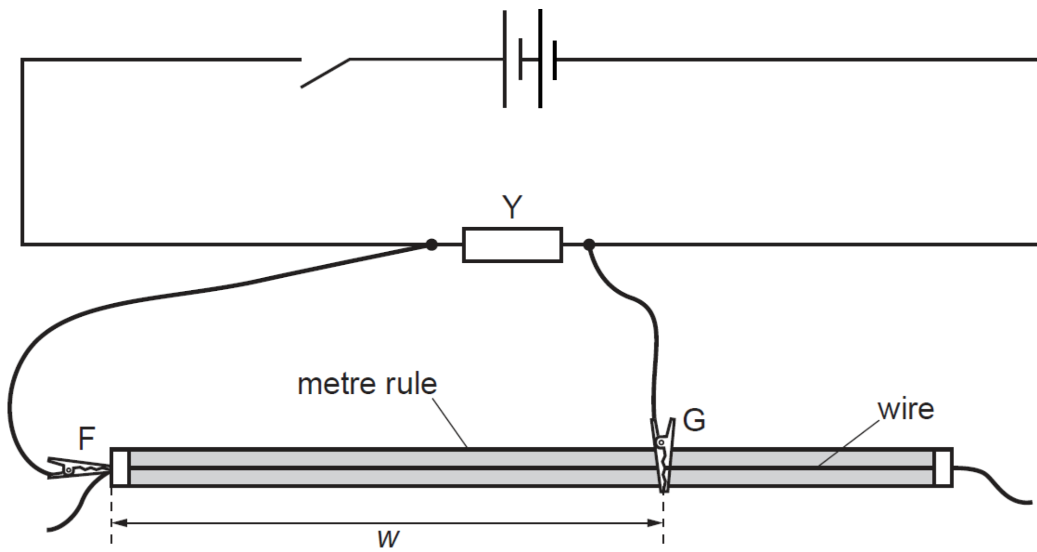


Fig. 3.1

The distance between F and G, w, is approximately 70 cm.

Close the switch. Measure and record the value of w and the ammeter reading I_1. Open the switch.

w = ...

I_1 = ... [1]

(c) Using values of w greater than 50 cm, vary w until you have six sets of readings of w and I_1. These readings will be tabulated in **(f)**.

(d) Set up the circuit shown in Fig. 3.2.

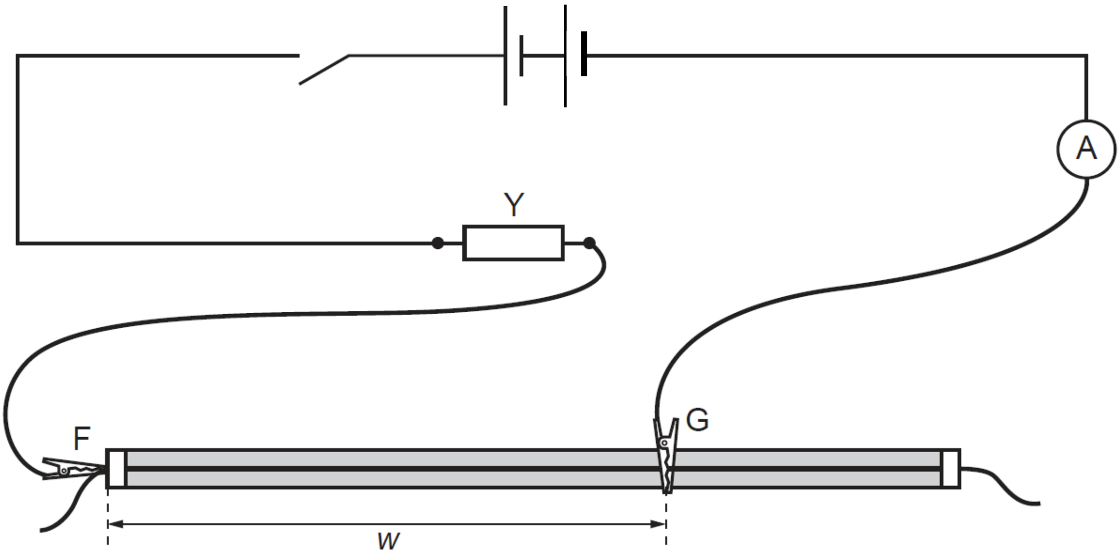


Fig. 3.2

(e) Close the switch. Measure and record the ammeter reading I_2. Open the switch.

I_2 = ... [1]

(f) Repeat **(e)**, using the **same** values of *w* in **(b)** and **(c)**, to obtain six corresponding readings of I_2. Tabulate all readings of *w*, I_1 and I_2. Include in your table $I_1 I_2$ and $\frac{1}{w}$. [4]

(g) Using the grid provided on **page 17**, plot a graph of $I_1 I_2$ against $\frac{1}{w}$. [4]

(h) Determine the gradient of your line of best fit.

Gradient = ………………………………. [2]

(i) The resistance of resistor Y, R_Y, can be determined using an alternative circuit.

1. Draw a suitable circuit diagram that can be used to determine R_Y. [1]

2. Set up the circuit as shown in your diagram. Measure and record all the necessary readings required to determine R_Y. [2]

3. Using the recorded readings, calculate the value of R_Y.

R_Y = ………………………………. [2]

(j) State one key source of error and indicate how it affects the accuracy of the readings.

……

……[1]

(k) A student theorised that the general equation for the experiment can be written as

$$I_1 I_2 = \frac{E^2}{R_Y}\left(\frac{1}{R_V}\right) \qquad \text{where } R_V \text{ is a variable resistor.}$$

He further suggested that the equation is valid for a light-dependent resistor (LDR) and a thermistor. Comment on the validity of this proposed theory.

……

……

……

……[1]

[Total : 20 m]

END OF PAPER

BLANK PAGE