NAME:	NO:	CLASS:

ADMIRALTY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2024

SUBJECT	:	Physics
CODE/PAPER	:	6091/3
LEVEL/STREAM	:	Secondary 4 Express
DATE	:	14 August 2024
DURATION	:	1 hour 50 minutes

Instructions to candidates:
Write your name, index number and class on the cover page.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions in the space provided.
Candidates are reminded that all quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
The number of marks is given in brackets [ ] at the end of each question or part question.

If the degree of accuracy is not specified in the question and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
At the end of the examination, fasten all your work securely together.

For Examiner's Use	
Paper 3	/ 40

DO NOT TURN OVER THIS PAPER UNTIL YOU ARE TOLD TO DO SO.

Section A

1 *In this experiment, you will investigate the specific heat capacity of a slotted mass.*

You have been provided with

- a thermometer
- a 100 g slotted mass, made of brass, with a length of string attached
- a polystyrene foam cup,
- a plastic stirrer,
- a plastic dropper,
- a glass beaker,
- a measuring cylinder,
- a piece of cloth,
- a supply of hot water.

(a) **(i)** Using the measuring cylinder, pour 100.0 cm^3 of tap water into the polystyrene foam cup. Set up the apparatus as shown in Fig. 1.1.

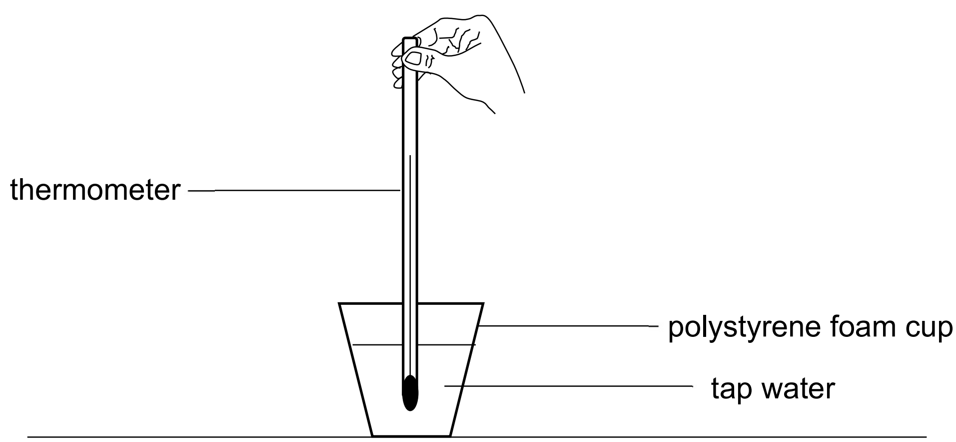

Fig. 1.1

(ii) Record the temperature θ_T of the tap water in the polystyrene foam cup.

θ_T = ………………………. [1]

(iii) A volume of 1.0 cm^3 of water has a mass of 1.0 g. Record the mass m_w of water in the polystyrene foam cup.

m_w = ………………………. [1]

(b) **(i)** Collect approximately 150 cm^3 of hot water with the plastic beaker. Gently lower the 100 g slotted mass into the plastic beaker of hot water using the attached string. Let the string rest over the edge of the plastic beaker so that it **does not** drop into the hot water.

(ii) Measure the temperature of the hot water in the plastic beaker and record the highest temperature reached as θ_H.

θ_H = ... [1]

(iii) Using the attached string, carefully transfer the slotted mass from the hot water to the polystyrene foam cup. Rest the string over the edge of the polystyrene foam cup so that it **does not** drop into the hot water.

(iv) Using the plastic stirrer, stir the water in the polystyrene foam cup slowly. Measure and record the highest temperature θ_F of the water while the slotted mass is still in the polystyrene foam cup.

θ_F = ... [1]

(c) The specific heat capacity c_{brass} of brass is given by the equation

$$c_{brass} = \frac{m_w c_w(\theta_F - \theta_T)}{m_{brass}(\theta_H - \theta_F)}$$

where the specific heat capacity of water c_w is 4.2 J/(g °C).

Calculate the specific heat capacity of brass, c_{brass}.

c_{brass} = ... [2]

(d) **(i)** State two reasons why the calculated value of c_{brass} is **not** equal to the actual value of the specific heat capacity of brass.

1 ………………………………………………………………………………

………………………………………………………………………………

2………………………………………………………………………………

……………………………………………………………………………… [2]

(ii) State and explain two improvements to the experiment to reduce the effect of the reasons cited in part **(d)(i)**.

1 ………………………………………………………………………………

………………………………………………………………………………

2………………………………………………………………………………

……………………………………………………………………………… [2]

2 *In this experiment, you will determine an accurate value for the mass of a 30 cm plastic ruler.*

You have been provided with

- a 30 cm plastic ruler with a mm scale,
- a 10 g mass,
- a pivot (knife-edge).

(a) Fig. 2.1 shows a 30 cm ruler of total length L.

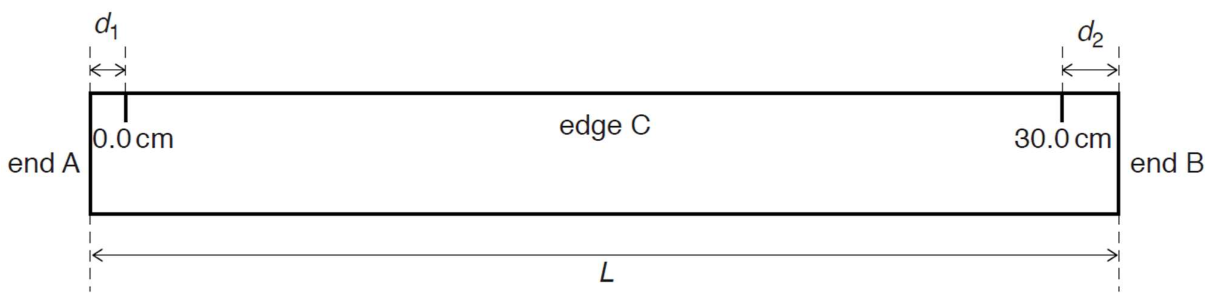

Fig. 2.1

At one end of the ruler there is a 'dead space' of length d_1 before the 0.0 cm mark and at the other end there is a 'dead space' of length d_2 after the 30.0 cm mark.

(i) Place the ruler provided on Fig. 2.2.

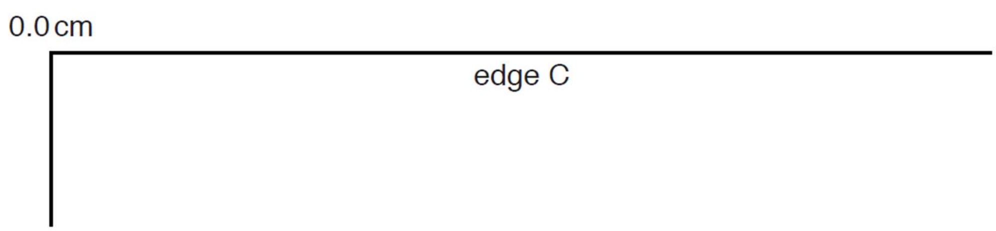

Fig. 2.2

Align the 0.0 cm mark and edge C of the ruler with the lines in the diagram. Draw a line on Fig. 2.2 to mark the position of end A of the ruler. Using Fig. 2.2, measure d_1.

d_1 = ……………………………..

(ii) Using Fig. 2.3, repeat **(a)(i)** with end B and measure d_2.

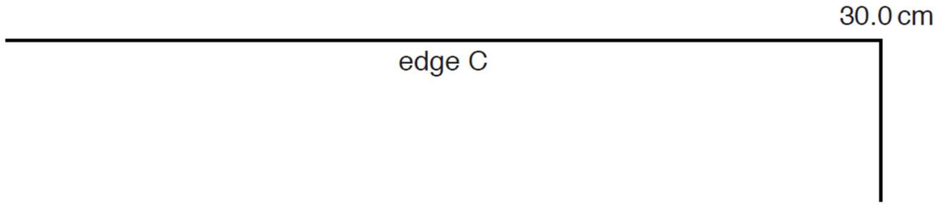

Fig. 2.3

d_2 = ...

(iii) Calculate the total length L of the ruler.

L = ... [2]

(b) (i) Place the ruler on the pivot. Move the position of the ruler until it balances horizontally. Record the reading S_1 on the ruler at the position of the pivot.

S_1 = ...

(ii) Place the 10 g mass so that its outer edge is at the 30.0 cm mark on the ruler.
Record the reading S_2 on the ruler at the position of the centre of the 10 g mass.

S_2 = ...

(iii) With the 10 g mass position in **(b)(ii)**, place the ruler on the pivot and move the position of the ruler until it balances horizontally.

The arrangement is shown in Fig. 2.4.

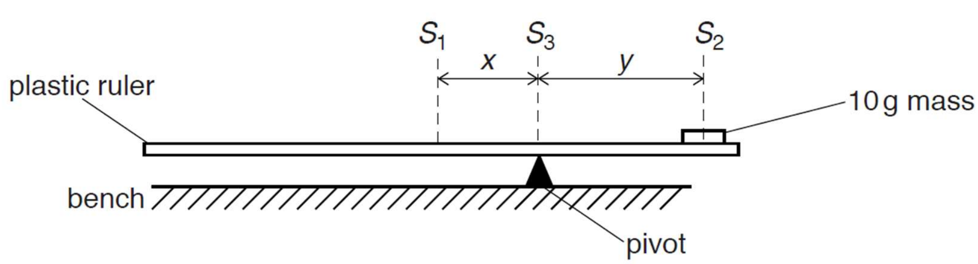

Fig. 2.4

Record the reading S_3 on the ruler at the pivot.

S_3 = ...

(iv) Determine the distances x and y shown on Fig. 2.4.

x = ………………………………..

y = ……………………………….. [2]

(c) Calculate the mass M of the ruler using $M = \frac{10y}{x}$.

M = …………………………….. [1]

(d) The relationship

$$M = \frac{10y}{x}$$

can be investigated using the same apparatus as in Fig. 2.4.

Plan an experiment to verify the relationship of the equation.

Your plan should include

- the quantities that you should keep constant,
- a detailed description of how you will perform the experiment,
- a suitable table in which to display your measurements and calculated values,
- a statement of the graph that you would plot to test the relationship,
- a sketch of the graph that you would obtain if the suggested relationship is correct,
- an explanation of how you would obtain a value of the mass M of the ruler from your graph.

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[5]

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Section B

3 *In this experiment, you will investigate the focal length of a converging lens.*

You have been provided with

- a converging lens,
- a cross-wire object to be illuminated,
- a lens stand,
- a light source (torchlight, mounted onto a retort stand),
- a screen,
- a metre rule,
- a set square,
- blu-tack.

(a) Set up the apparatus provided as shown in Fig. 3.1.

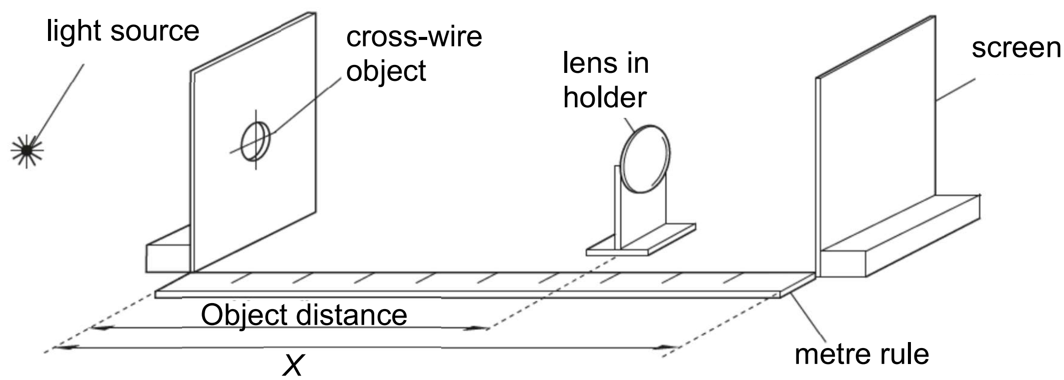

Fig. 3.1

Place the cross-wire object at the 0.0 cm end of the metre rule and the screen at the 100.0 cm end.
By only changing the position of the lens, obtain a focused *diminished* image of the object on the screen.

Describe the process and techniques used to ensure a focused image of the object on the screen.

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…………………………………………………………………………………… [4]

(b) Determine the accurate value for the distance U_D between the object and the lens when the diminished image of the object is in sharp focus on the screen.

U_D = …………………….. [2]

(c) By only changing the position of the lens, obtain a *magnified* image of the object on the screen.

(i) Determine the new value for the object distance U_M when the *magnified* image of the object is in sharp focus on the screen.

U_M = …………………….. [1]

(ii) In order to change from a diminished image to a magnified image, the lens has to be moved through a distance d.

1. Calculate d, using the equation $d = U_D - U_M$.

d = …………………….. [1]

2. Calculate y, using the equation $y = X^2 - d^2$, where X is the distance between the object and the screen.

y = …………………….. [1]

(d) By placing the screen at different positions along the metre rule, repeat **(b)** and **(c)** using further values of *X* in the range 75 cm $\leq X \leq$ 95 cm.

The object should remain at the 0.0 cm mark on the rule and the position of the screen should be changed to give the different values of *X*.

Record your results for *X*, U_D, U_M, *d* and *y* in a table below. Also include your results from **(b)** and **(c)** in the table.

[4]

(e) Using the grid opposite, plot a graph of *y* against *X*. [4]

(f) **(i)** Determine the gradient G of your graph.

G = …………………………….. [2]

(ii) The numerical value f of the focal length of the lens is given by

$$f = \frac{G}{4}$$

Calculate f.

f = ………………………………… [1]

END OF PAPER