RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749
PAPER 4

22 AUG 2024

2 HRS 30 MIN

CANDIDATE NAME										
CENTRE NUMBER	S					**INDEX NUMBER**				
CLASS	2	3	J							

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

Candidates answer 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.

SHIFT
LABORATORY

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

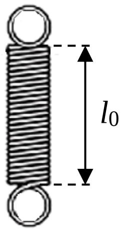
The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINERS' USE	
1	**/ 21**
2	**/ 12**
3	**/ 10**
4	**/ 12**
TOTAL	**/ 55**

This document consists of **18** printed pages.

1 In this experiment, you will investigate the spring constant of a spring using the principle of moments.

(a) **(i)** Measure and record the length l_0 of the coiled section of the unstretched spring using the 30 cm ruler.



l_0 = ……………………….. [1]

(ii) Hang a mass *m* of 300 g as shown in Fig. 1.1 below and measure the length l_1 of the stretched spring. Calculate the extension, $(l_1 - l_0)$.

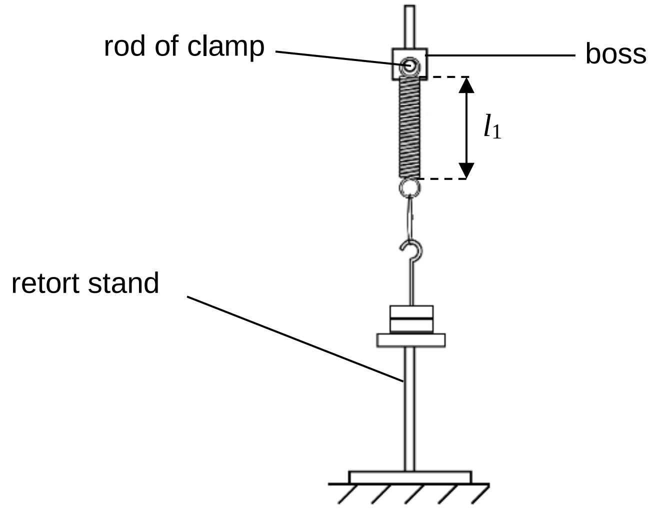


Fig. 1.1

$l_1 - l_0$ = ……………………….. [1]

(iii) The spring constant of the spring *k* is given by the expression

$$k = \frac{mg}{l_1 - l_0}$$

where *m* is the mass used in **(a)(ii)** and g = 9.81 m s^{-2}.
Use your answer in **(a)(ii)** to calculate the spring constant of the spring *k*.

k = ……………………….. [1]

(b) Disconnect the previous setup and set up the apparatus as shown in Fig. 1.2.

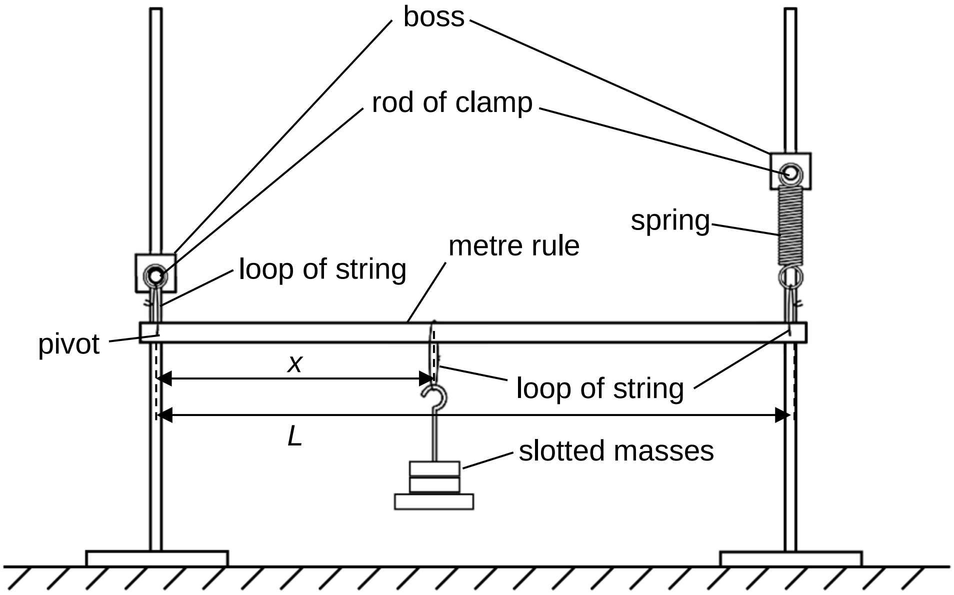


Fig. 1.2

The distance *x* is the distance between the 300 g mass to the pivot, and the distance *L* is the distance between the pivot to the spring.

Set *x* to be approximately 40 cm.

Adjust the apparatus such that the metre rule is always parallel to the bench.

(i) Displace the right end of the metre rule downwards over a short distance and release it. Allow the metre rule to oscillate about the pivot.

Record *x* and determine the period *T* of these oscillations.

x = ………………………..

T = ……………………….. [1]

(ii) Estimate the percentage uncertainty in *T*.

percentage uncertainty in *T* = ……………………….. [1]

(iii) Repeat step **(b)(i)** for further values of *x* and *T*. The value of *x* should be more than 35 cm. Present your results clearly.

[5]

(iv) The quantities *T* and *x* are related by the expression

$$T^2 = C + Dx^2$$

where *C* and *D* are constants.

Plot a suitable graph to determine *C* and *D*.

C = ………………………..

D = ………………………... [6]

(c) Explain why you should not use a value of x that is much smaller than 35 cm.

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

(d) The constant D is directly proportional to the mass of the slotted masses m.

This experiment is then repeated with a larger mass m. Sketch a line on your graph grid on page 5 to show the expected result.

Label this line W. [1]

(e) It is hypothesized that the spring constant k is inversely proportional to T. To vary k, attach an additional spring using the S-hook as shown in Fig. 1.3 below. A spring system with two springs connected in series has half of the spring constant compared to that of a single spring.

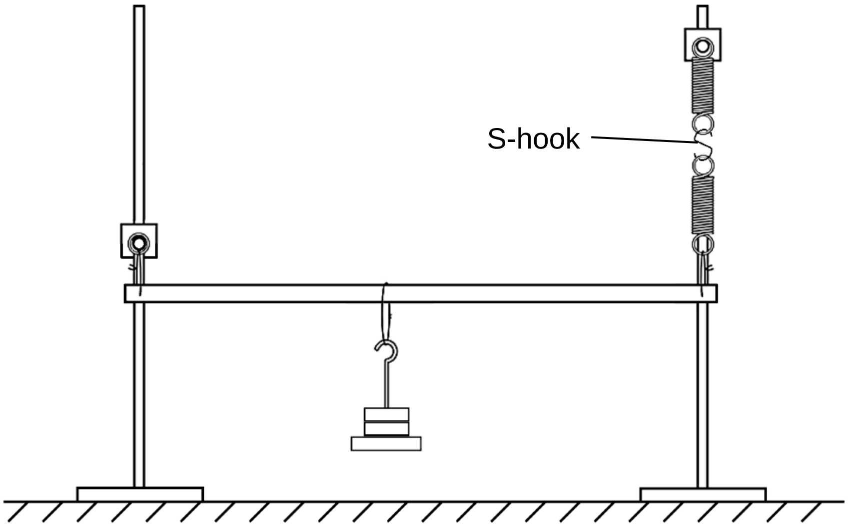

Fig. 1.3

By using your results in **(b)(i)** and taking one additional set of data, investigate whether this hypothesis is valid. Tabulate your results clearly.

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[Total: 21]

2 This investigation will consider current in an electrical circuit.

(a) **(i)** Assemble the circuit as shown in Fig. 2.1.

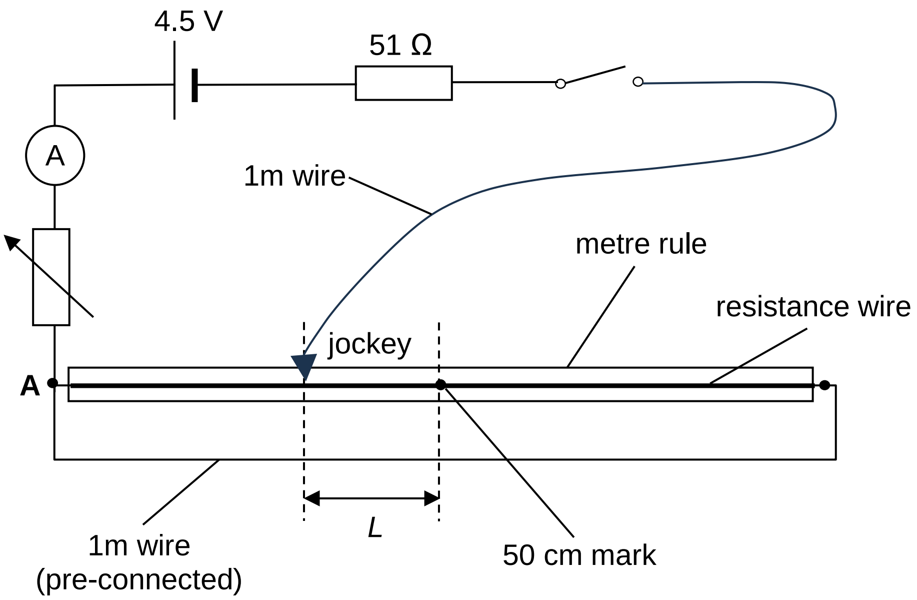


Fig. 2.1

(ii) With the jockey pressed onto point A, adjust the rheostat until the ammeter reading is in the range 50 – 80 mA. Record the ammeter reading I_0.

I_0 = ……………………….. [1]

(b) **(i)** Press the jockey onto the wire half-way between point A and the 50 cm mark.

Record its distance *L* from the 50 cm mark and the ammeter reading I .

L = ………………………..

I = ……………………….. [1]

(ii) Estimate the percentage uncertainty in your value of I in **(b)(i)**.

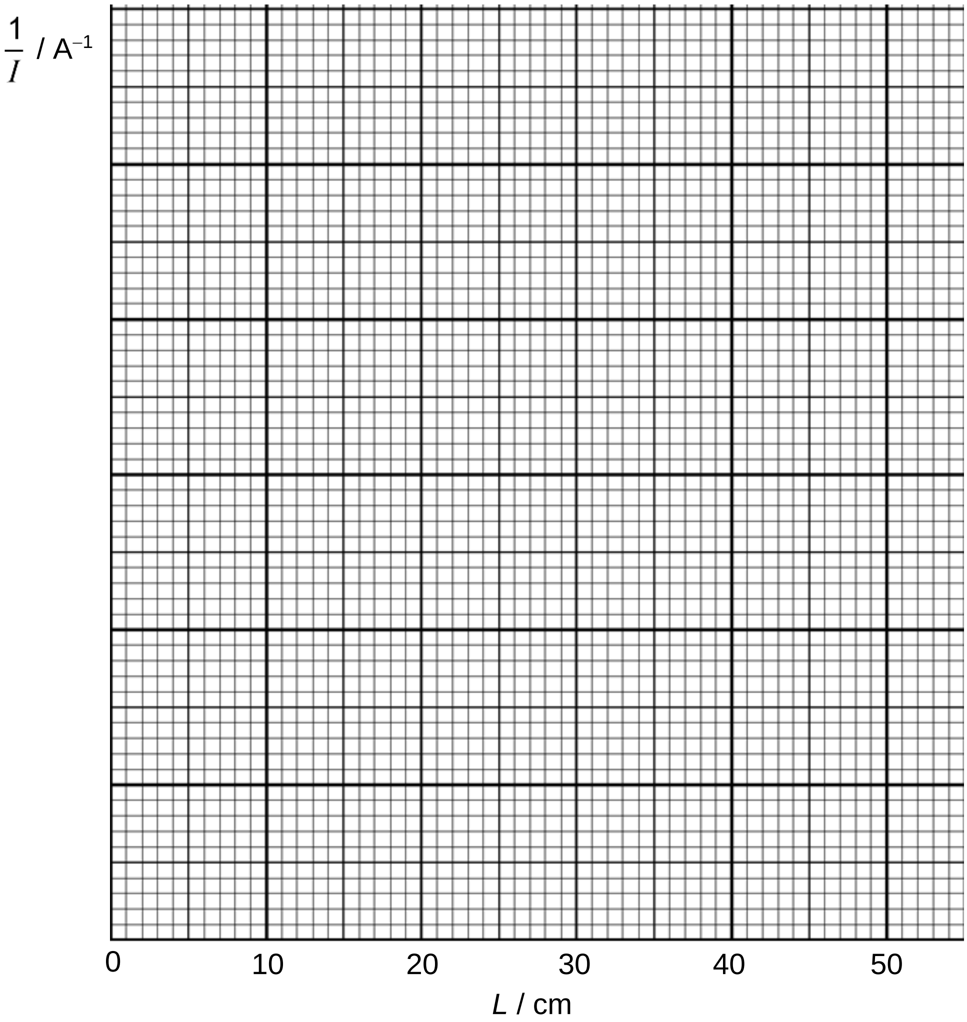
percentage uncertainty = ……………………….. [1]

(c) **(i)** Change L by placing jockey between point A and the 50 cm mark. Repeat **(b)(i)**.

Present your results clearly.

[3]

(ii) Plot values of $\frac{1}{I}$ against L on the grid. The graph obtained should be a curve. [2]



(d) The quantities L and I are related by the equation

$$\frac{1}{I} = aL^2 + b$$

where a and b are constants.

By selecting 2 points that lie on the graph plotted in **(c)(ii)**, determine the values of a and b.

Present your working clearly.

Give appropriate units.

a = ………………………..

b = ……………………….. [2]

(e) **(i)** Theory suggests that the total resistance in the circuit is the largest when the jockey is pressed onto point A. Therefore, the current in the circuit will be a minimum.

Using the value of current I_0 in **(a)(i)**, calculate the reciprocal of the ammeter reading $\frac{1}{I_0}$.

$\frac{1}{I_0}$ = ………………………..

(ii) Plot the value of $\frac{1}{I_0}$ in **(e)(i)** on the graph in **(c)(ii)**.

Label this point M at L = 50.0 cm.

(iii) State whether this point agrees with the pattern of the other points on your graph.

Use your values in **(b)(ii)** to justify your statement.

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[Total: 12]

3 This experiment concerns the force needed to pull a cylinder-shaped object up a step.

(a) Using a micrometer screw gauge, measure the thickness h of the board, as shown in Fig. 3.1.

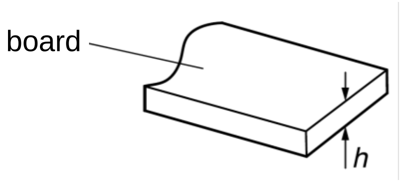

Fig. 3.1

h = ……………………….. [1]

(b) Suspend the two **larger** (100 g) slotted masses from the newton-meter using the loop of thread, as shown in Fig. 3.2.

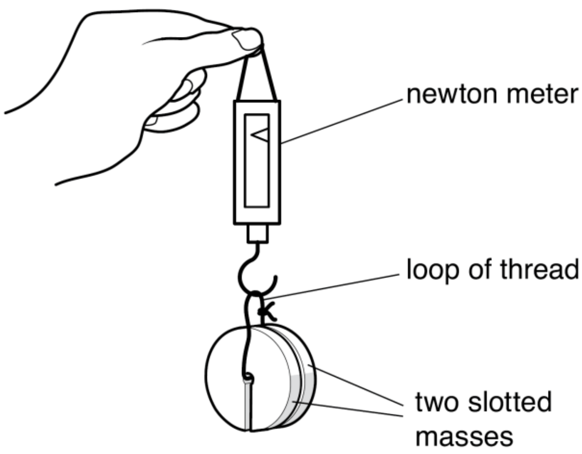

Fig. 3.2

Record the total weight W of these masses.

W = ……………………….. [1]

(c) (i) Take measurements to determine the radius r of one of the larger slotted masses.

r = ……………………….. [1]

(ii) The value of α is given by

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

Calculate α.

α = ……………………….. [1]

(d) Place the board on the bench to make a step. Stand the two larger slotted masses (pre-taped) on their edges next to the step with their slots at the left, as shown in Fig. 3.3.

Attach the loop of thread to the masses and the newton-meter, as shown in Fig. 3.3.

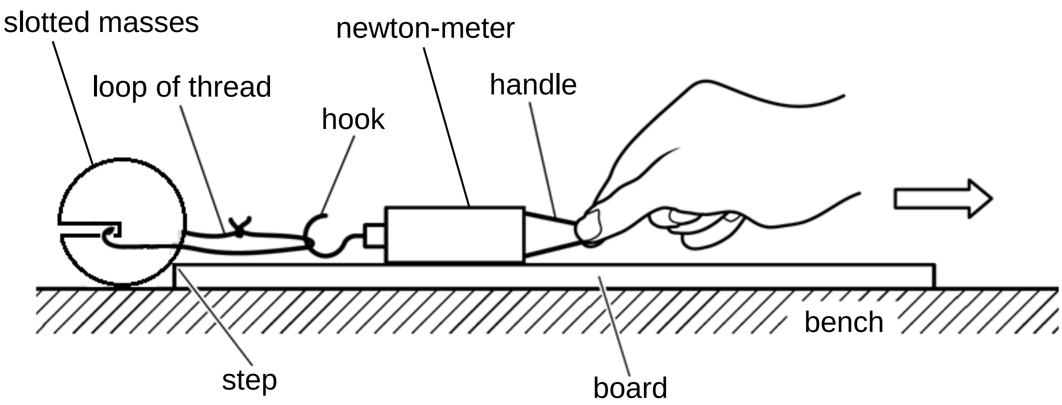

Fig. 3.3

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 = ………………………..

(e) Repeat **(b)**, **(c)(i)**, **(c)(ii)**, and **(d)** using the two smaller (50 g) slotted masses (pre-taped).

W = ………………………..

r = ………………………..

α = ………………………..

F = ……………………….. [1]

(f) It is suggested that the normal contact force *N* that the **bench exerts on** the slotted masses is directly proportional to force *F* so long as the slotted masses have not rolled up the step.

Explain how you might modify the set up to investigate this relationship between *N* and *F*.

Your account should include:

- your modifications to the setup
- your experimental procedure
- control of variables
- how you would use your results to show direct proportionality.

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[Total: 10]

4 A Geiger-Müller (GM) counter is used for measuring and detecting ionising radiation. It consists of a gas-filled tube containing electrodes, between which there is an electrical voltage, but no current flowing. When ionising radiation passes through the tube, the gas gets ionised and the number of charges flowing per unit time is measured with the ratemeter.

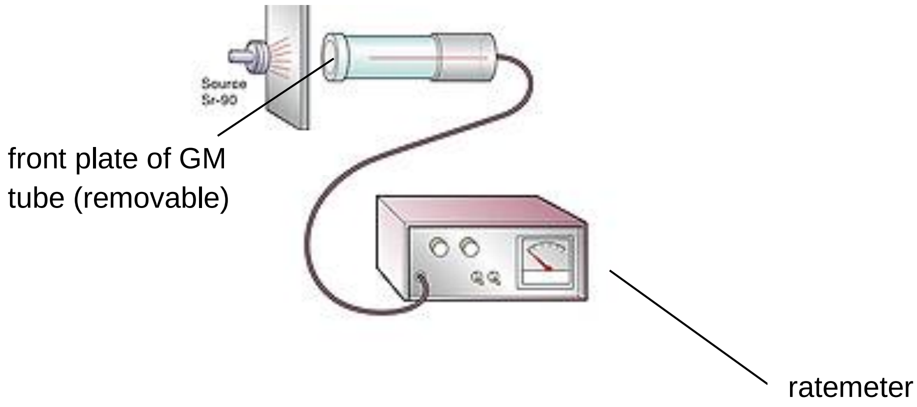

Fig. 4.1

A student suggests that the count rate C of a radioactive sample is related to the distance d of the sample away and the thickness t of the front plate of the tube that allows ionising radiation to enter the tube via the following equation:

$$C = kd^M t^N$$

where k, M and N are constants.

You are provided with a small sample of strontium-90 which is a β-particle emitter, you may assume that its activity is constant. You are also provided with a GM tube, a ratemeter and front plates for GM tube of different unmarked thicknesses.

Design an experiment to determine the values of M and N.

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

(a) the identification and control of variables,
(b) the procedure to be followed,
(c) the control of variables
(d) any precautions that would be taken to improve the safety and accuracy of the experiment.

Diagram

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[Total: 12]

End of Paper