Name:	Class:	Class Index No.:

Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2024

SECONDARY FOUR EXPRESS

PHYSICS 6091

PRACTICAL

1 HOUR 50 MINUTES

INSTRUCTIONS TO CANDIDATES:

Write your name, class and exam index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Read the instructions carefully.

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

For Examiner's Use	
Q1	
Q2	
Q3	
Total	40

*This question paper consists of **13** printed pages.*

Section A

1 *In this experiment, you will investigate an electric motor.*

You have been provided with

- a battery
- a switch
- an ammeter
- a length of resistance wire attached to a metre rule
- an electric motor clamped to a stand
- a piece of thin card
- a voltmeter
- connecting leads
- a jockey

Assemble the circuit shown in Fig. 1.1.

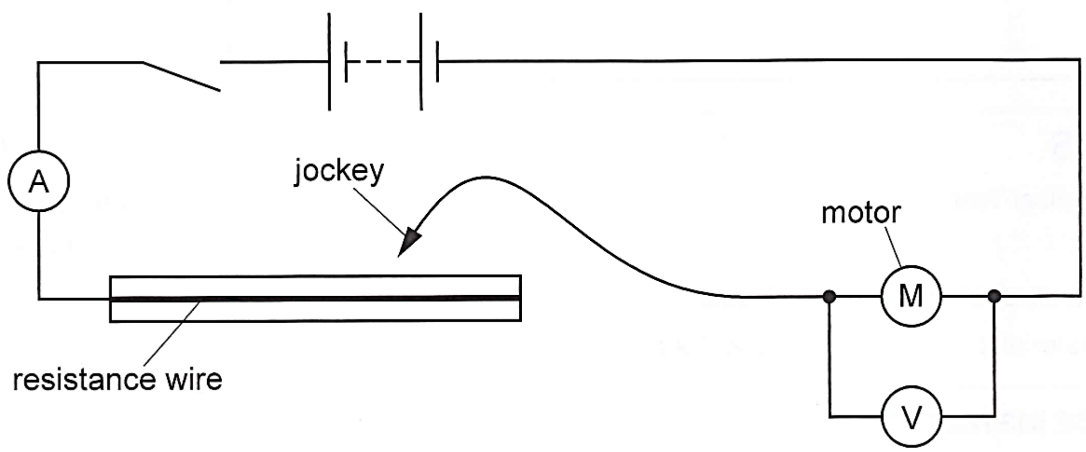


Fig. 1.1

The jockey can be connected at different points along the length of the resistance wire.

You are also provided with:

- a load made from a 50 g mass hanger and three 50 g masses
- an elastic band.

Place the shaft of the motor through the elastic band and suspend the load from the elastic band. Put the piece of thin card onto the shaft of the motor, as shown in Fig. 1.2.

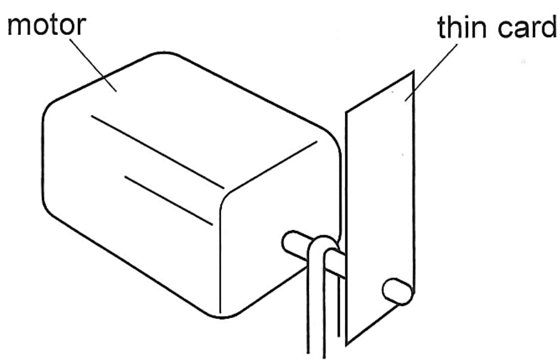


Fig. 1.2

Tilt the motor very slightly, as shown in Fig. 1.3, to ensure that the elastic band does not slip off when the shaft of the motor is turning.

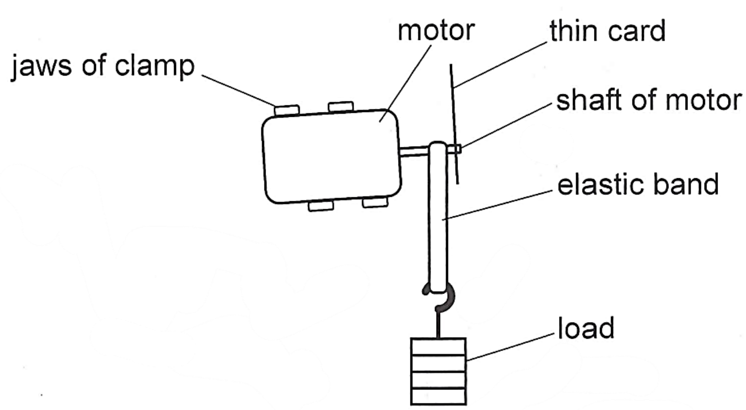


Fig.1.3

Close the switch.

Connect the jockey to the resistance wire. Adjust the position of the jockey until the shaft of the motor rotates as slowly as possible without stopping. The piece of thin card can help you judge when the motor starts to rotate.

(a) Record the potential difference V across the motor and the current I in the circuit.

V = ...

I = ...
[2]

(b) Open the switch. Disconnect the jockey from the resistance wire.

Calculate:

(i) the power P input to the motor, using the equation $P = V I$

P = ... [1]

(ii) the ratio R of the potential difference to the current, using the equation

$$R = \frac{V}{I}$$

.

R = ... [1]

(c) Remove **one** 50 g mass from the load.

Close the switch.

Connect the jockey to the resistance wire. Adjust the position of the jockey until the shaft of the motor rotates as slowly as possible without stopping.

(i) Calculate new values of P and R for this load.

P = ...

R = ...
[1]

(ii) The load has decreased by 25%.

Compare the decrease in the load with the change in *P* and with the change in *R*.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..[2]

(d) Other students perform the same experiment.

Describe **three** reasons why the readings obtained may be different.

1 …………………………………………………………………………………………………….

……………………………………………………………………………………………………

2 …………………………………………………………………………………………………….

……………………………………………………………………………………………………

3 …………………………………………………………………………………………………….

……………………………………………………………………………………………………
[3]

[Total: 10]

2 *In this experiment, you will investigate the oscillation of a metre rule.*

You have been provided with:

- a metre rule with a loop of thread attached
- a boss attached to a stand
- a spring
- an S-hook
- a 200 g mass
- adhesive putty
- a 50 cm rule
- a stop-watch.

Assemble the apparatus shown in Fig. 2.1.

Secure the 100 cm end of the rule to the bench with adhesive putty.

Use adhesive putty to attach the centre of the 200 g mass at the 2 cm mark on the metre rule.

Use the S-hook to attach the lower loop of the spring to the loop of thread on the metre rule.

Adjust the position of the boss on the stand until the height *h* of the bottom of the metre rule at the 0 cm end is approximately 3 cm above the bench. The extension of the spring is now *x*.

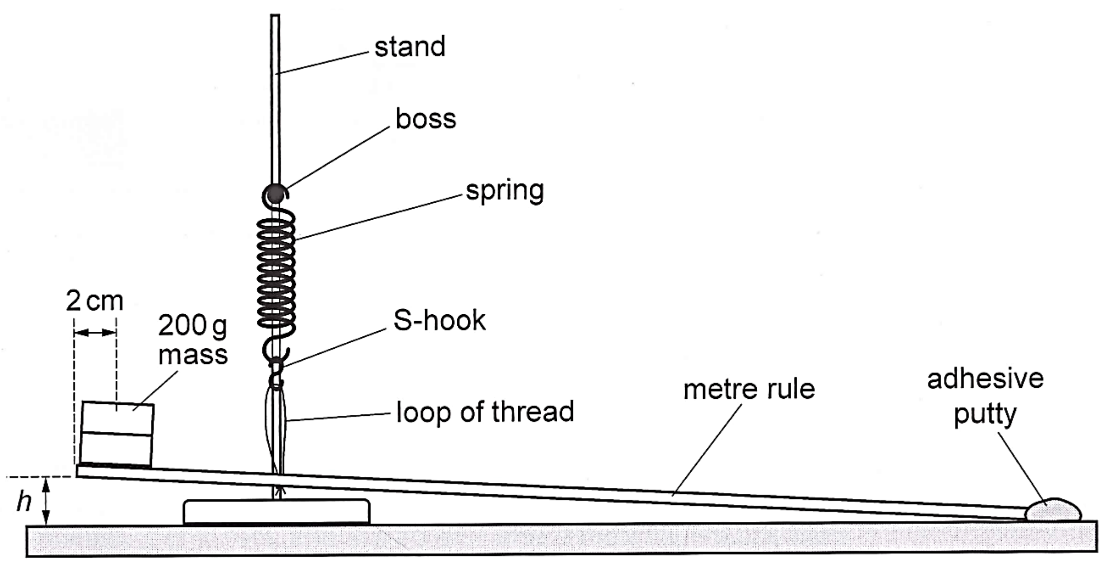


Fig. 2.1

(a) **(i)** Push the 0 cm end of the metre rule down until it almost touches the bench. Release the metre rule and observe the oscillation.

Determine an accurate value for the period T of the oscillation.

T = ……………………………….[2]

(ii) Calculate T^2.

T^2 = ……………………………….[2]

(b) A student claims that $T^2 = ax + b$, where a and b are constants and x is the extension of the spring.

Plan an experiment to investigate the student's claim.

In your plan, you should:

- explain briefly how to do the experiment
- describe how to determine x
- state **one** key variable to control
- draw a table, with column headings, to show how to display the range of readings
- explain how to determine a and b if the student's claim is correct.

……

……

……

……[6]

[Total: 10]

Section B

3 *In this experiment, you will investigate the focal length of a combination of lenses.*

You have been provided with:

- a pair of converging lenses mounted on a block
- a torch
- a screen
- a stand, boss and clamp
- a 50 cm rule.

Assemble the apparatus as shown in Fig. 3.1.

There is a card with a triangular hole mounted on the front of the torch.

Use the stand, boss and clamp to hold the torch level with the centre of the lenses. Place the torch so that the triangle is at the 0.0 cm mark on the 50 cm rule. Switch on the torch.

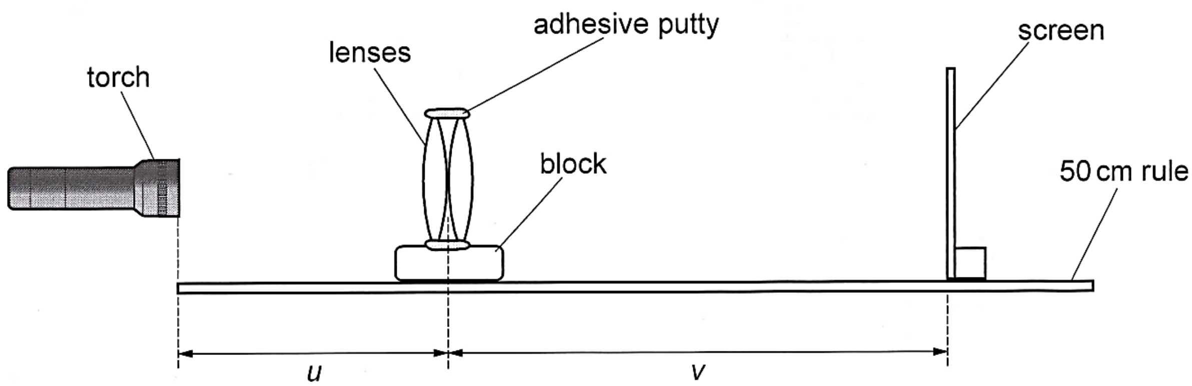


Fig. 3.1

Place the centre of the combination of lenses at u = 15.0 cm and move the screen until a focused image of the triangle is formed on the screen. The distance v is measured between the centre of the combination of lenses and the screen where the image is focused.

(a) Describe the process and techniques used to ensure a focused image of the triangle forms on the screen.

....

....

....

....

....

....

....[4]

(b) Determine an accurate value for the distance v.

v = ……………………….. [2]

(c) Record your values of u and v in a table. Include a column for ($u + v$) and a column for uv.

For values of u from 15.0 cm to 25.0 cm, determine corresponding values of v, ($u + v$) and uv. Record all of your measurements and calculations in your table.

[5]

(d) Using the grid provided, plot a graph of uv against ($u + v$). [4]

(e) The gradient of your line of best fit is numerically equal to the focal length f of the combination of lenses.

Determine f.

f = ……………………….. [2]

(f) Describe **three** improvements to the experiment that reduce experimental error.

1 …………………………………………………………………………………………………….

……………………………………………………………………………………………………

2 …………………………………………………………………………………………………….

……………………………………………………………………………………………………

3 …………………………………………………………………………………………………….

……………………………………………………………………………………………………
[3]

[Total: 20]

[Blank Page]

[Blank Page]

Name: TEACHER'S ANSWERS.	Class:	Class Index No.:

THE BEST IS YET TO BE

Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2024

SECONDARY FOUR EXPRESS

PHYSICS 6091

PRACTICAL

1 HOUR 50 MINUTES

INSTRUCTIONS TO CANDIDATES:

Write your name, class and exam index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Read the instructions carefully.

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

For Examiner's Use	
Q1	
Q2	
Q3	
Total	/ 40

*This question paper consists of **13** printed pages.*

Section A

1 *In this experiment, you will investigate an electric motor.*

You have been provided with

- a battery
- a switch
- an ammeter
- a length of resistance wire attached to a metre rule
- an electric motor clamped to a stand
- a piece of thin card
- a voltmeter
- connecting leads
- a jockey

Assemble the circuit shown in Fig. 1.1.

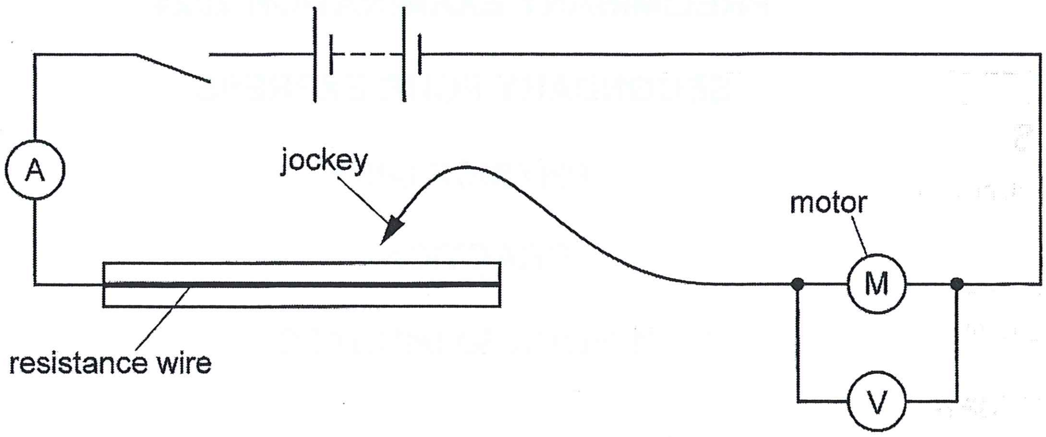


Fig. 1.1

The jockey can be connected at different points along the length of the resistance wire.

You are also provided with:

- a load made from a 50 g mass hanger and three 50 g masses
- an elastic band.

Place the shaft of the motor through the elastic band and suspend the load from the elastic band. Put the piece of thin card onto the shaft of the motor, as shown in Fig. 1.2.

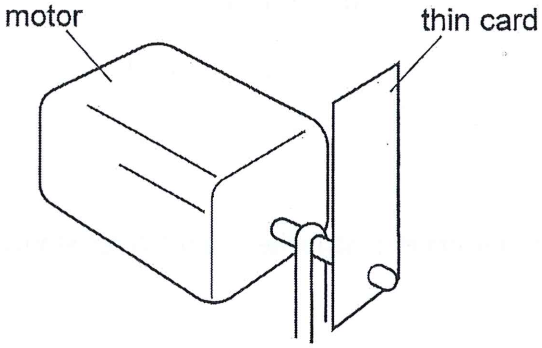


Fig. 1.2

Tilt the motor very slightly, as shown in Fig. 1.3, to ensure that the elastic band does not slip off when the shaft of the motor is turning.

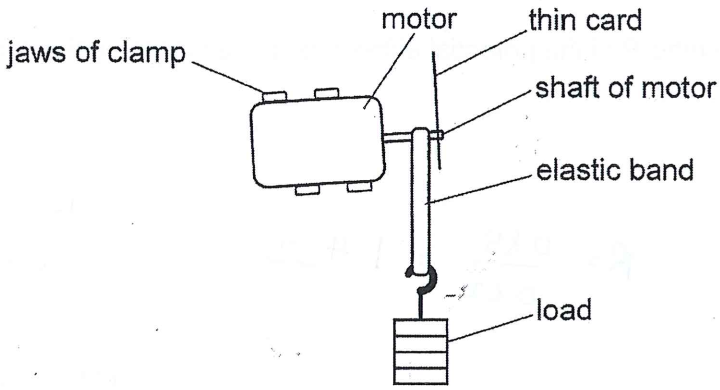


Fig.1.3

Close the switch.

Connect the jockey to the resistance wire. Adjust the position of the jockey until the shaft of the motor rotates as slowly as possible without stopping. The piece of thin card can help you judge when the motor starts to rotate.

(a) Record the potential difference V across the motor and the current I in the circuit.

- V = nearest 0.05 V
- I = nearest 0.01 A

V = 0.85 V [A1]

I = 0.62 A [A1]

[2] MMO

(b) Open the switch. Disconnect the jockey from the resistance wire.

Calculate:

- P = least sf-(2sf)
- units given

(i) the power P input to the motor, using the equation $P = VI$

$P = 0.85 \times 0.62 = 0.53\ W$

* Allow ecf for wrong dp values from 1a

*Penalise if no workings shown

P = 0.53W [A1] [1] MMO

(ii) the ratio R of the potential difference to the current, using the equation

$$R = \frac{V}{I}$$

* Allow ecf for wrong dp values from 1a

- R = least sf. (2sf)
- unit given.

$R = \frac{0.85}{0.62} = 1.4\ \Omega$

*Penalise if no workings shown

R = 1.4 Ω [A1] [1] MMO

(c) Remove **one** 50 g mass from the load.

Close the switch.

Connect the jockey to the resistance wire. Adjust the position of the jockey until the shaft of the motor rotates as slowly as possible without stopping.

(i) Calculate new values of P and R for this load.

* Penalise if no workings shown

$P = 0.75 \times 0.40 = 0.30\ W$

$R = \frac{0.75}{0.40} = 1.9\ \Omega$ (2sf)

- P to least sf (2sf)
- R to least sf (2sf)

P = 0.30W [A1]

R = 1.9Ω

[1] MMO

$$\text{decrease in } P = \frac{0.53-0.30}{0.53} \times 100\% = 43\%$$

$$\text{Increase in } R = \frac{1.9-1.4}{1.9} \times 100\% = 26\%$$

(ii) The load has decreased by 25%.

Compare the decrease in the load with the change in *P* and with the change in *R*.

Decrease in load resulted in 43% decrease in P. [A1]

Decrease in load resulted in 26% increase in R. [A1]

*must quote values either by percentage/values

[2] ACE.

(d) Other students perform the same experiment.

Describe **three** reasons why the readings obtained may be different.

1 Estimation of the slowest possible rotation is different for each student and each try. [A1]

2 The angle of tilt of motor will be different for each student. [A1]

3 The position where the band is placed is different for each student. [A1]

[3] ACE

(other acceptable answer).

[Total: 10]

4) Resistance wire may be heated up caused the resistance of wire to increase

5) Different perceptions of the motor moving slowly.

6) Lesser friction on the elastic band over time

Reject

1) Kinks on wire (does not affect readings)
2) Elasticity of band

2 *In this experiment, you will investigate the oscillation of a metre rule.*

You have been provided with:

- a metre rule with a loop of thread attached
- a boss attached to a stand
- a spring
- an S-hook
- a 200 g mass
- adhesive putty
- a 50 cm rule
- a stop-watch.

Assemble the apparatus shown in Fig. 2.1.

Secure the 100 cm end of the rule to the bench with adhesive putty.

Use adhesive putty to attach the centre of the 200 g mass at the 2 cm mark on the metre rule.

Use the S-hook to attach the lower loop of the spring to the loop of thread on the metre rule.

Adjust the position of the boss on the stand until the height h of the bottom of the metre rule at the 0 cm end is approximately 3 cm above the bench. The extension of the spring is now x.

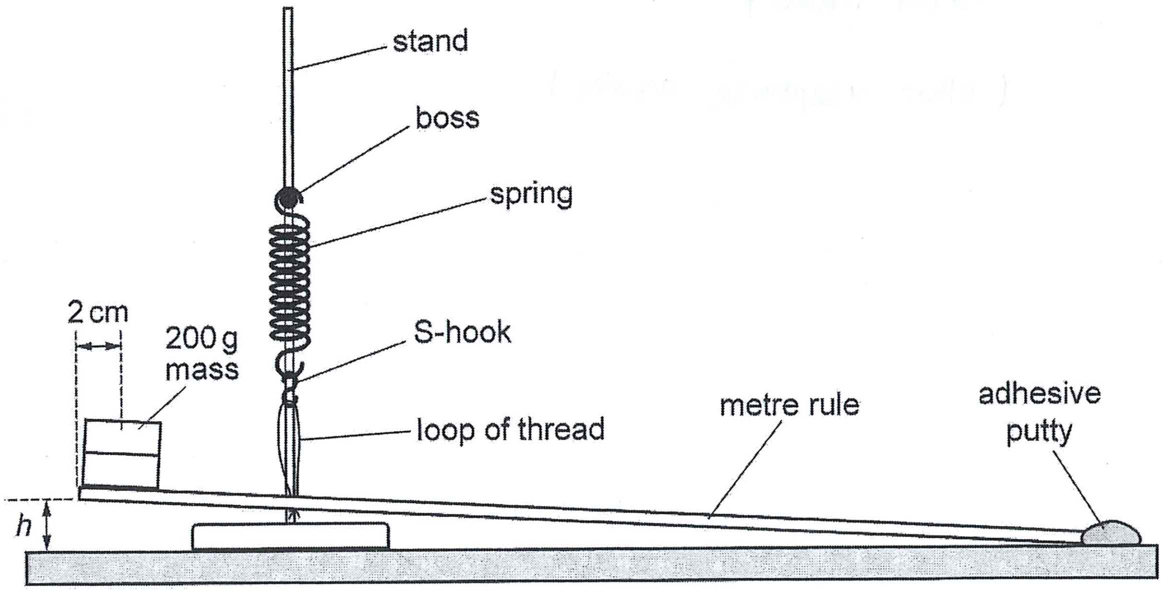


Fig. 2.1

(a) **(i)** Push the 0 cm end of the metre rule down until it almost touches the bench. Release the metre rule and observe the oscillation.

Determine an accurate value for the period T of the oscillation.

- Average T_{20} taken
- nearest 0.01 s

/ Average T taken

*Penalise if no workings shown. Give 0.

$T_{20} = \frac{13.55 + 13.32}{2} = 13.44\,s$ [A1]

at least 10 oscillations

$T = 13.44/_{20} = 0.6270\ s$

T = ...0.6270 s...... [A1] [2] ACE

- period calculated
- nearest sf. (4sf)

(ii) Calculate T^2.

correct method. [A1]

$T_2 = 0.6270 \times 0.6270$

$= 0.4516\ s$

- nearest sf (4sf)
- correct calculation

*Penalise if no workings shown. Give 0.

T^2 = ...0.4516 s [A1]......[2]

(b) A student claims that $T^2 = ax + b$, where a and b are constants and x is the extension of the spring.

* Once IV/DV is wrong, no credit awarded for 2,3,5,6

Plan an experiment to investigate the student's claim.

In your plan, you should:

Flow of plan ① A1 ② A1 Measure DV

- explain briefly how to do the experiment
- describe how to determine x A1 ③ State IV
- state **one** key variable to control A1 ④ State at least 1 out 2 constants.
- draw a table, with column headings, to show how to display the range of readings A1 ⑤ Repeat (values stated), Table correct
- explain how to determine a and b if the student's claim is correct. A1 ⑥ Plot, Conclusion

Examiners' Comment

Many candidates identified at least one key control variable, but a number of candidates produced plans that were not well-organised or were incoherent. A significant number of candidates were aware that at least five plausible values of the independent variable were needed but few stated an appropriate method to measure the extension of the spring. Stronger responses identified the independent variable as the position of the mass along the rule or the mass used and correctly described how the independent variable can be varied. Most candidates correctly stated the graph to plot and went on to describe how a and b can be determined from the graph.

unextended spring   extended spring

1) Measure the unextended spring length x_0 using a 50 cm rule.

2) Set up the experiment as shown in Fig 2.1. ①

3) Place a 200 g mass at 2cm mark with an adhesive putty.

Ensure that the mass is placed at the same position throughout the experiment. ④ 1st constant

4) measure the length of the extended spring x_1 using a 50 cm rule.

5) Calculate the extension of spring, x, by taking $x = x_1 - x_0$. 3

6) Adjust the boss until height h is approximately 3 cm. Ensure h is kept at the same value for every change in x 4 2nd constant

7) Push 0cm mark on the ruler down until it almost touches the bench and release it.

8) Using a stopwatch, measure the time taken for 20 oscillations, T_1. 2

9) Repeat step 8 to get second reading T_2.

10) Find T by using $T = \frac{T_1 + T_2}{20}$.

11) Calculate T^2 and record in the table below.

12) Repeat step 1 to 11 for further values of mass m = 250g, 300g, 350 g, 400 g, 450 g.

13) Record $m, x_0, x_1, x, T_1, T_2, T, T^2$ in a table.

m/g	x_0/cm	x_1/cm	x/cm	T_1/s	T_2/s	T/s	T^2/s^2
200 250 300 350 400 450							

5

14) Plot a graph of T^2 against x.

15) Calculate the gradient and y-intercept of the graph.

16) If the relationship is correct, a will be equal to the gradient and b will be equal to y-intercept. 6

$$T^2 = ax + b$$

↑ gradient ↑ y-intercept

[6] P

[Total: 10]

Section B

3 *In this experiment, you will investigate the focal length of a combination of lenses.*

Examiner's Comments:

Many candidates gave vague descriptions. When the torch was referenced, it was often unclear whether the candidate was referring to the height of the torch, the card with the triangular hole at the front of the torch or the direction the torch was pointing. A number paraphrased the question with '... until a focused image is formed on the screen'. Some candidates described ways to improve the experiment instead.

You have been provided with:

- a pair of converging lenses mounted on a block
- a torch
- a screen
- a stand, boss and clamp
- a 50 cm rule.

Assemble the apparatus as shown in Fig. 3.1.

There is a card with a triangular hole mounted on the front of the torch.

Use the stand, boss and clamp to hold the torch level with the centre of the lenses. Place the torch so that the triangle is at the 0.0 cm mark on the 50 cm rule. Switch on the torch.

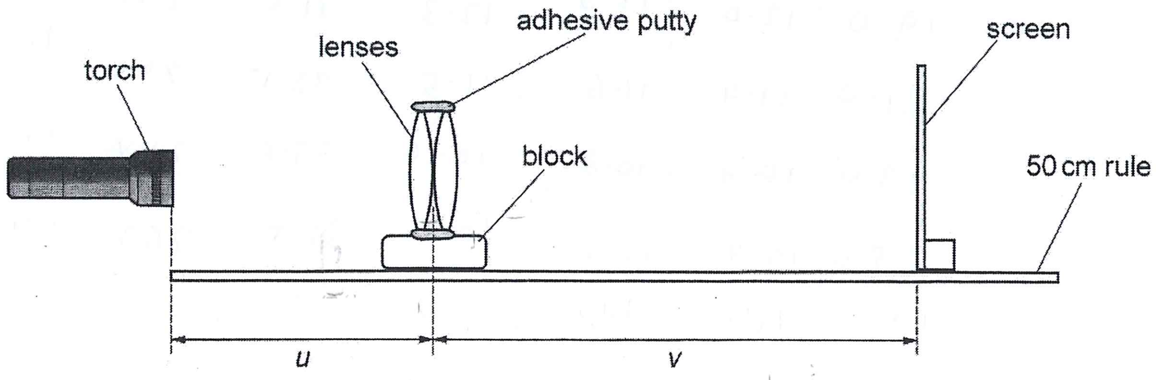


Fig. 3.1

Place the centre of the combination of lenses at u = 15.0 cm and move the screen until a focused image of the triangle is formed on the screen. The distance v is measured between the centre of the combination of lenses and the screen where the image is focused.

(a) Describe the process and techniques used to ensure a focused image of the triangle forms on the screen.

1) Align the triangular hole on the torch, the lens and the screen along a straight line. Use the half metre rule [A1] to ensure they are in a line. [A1]

2) Place the screen at the 50cm mark and bring it closer and closer to the lens until a sharp image of the triangular hole is formed. [A1]

3) Make small adjustments to the screen to ensure image is sharpest. [A1] ....[4] P

* Reject
- Focused image instead of sharp image
- Did not mention triangular hole, lens and screen must be in a straight line.

- calculation of average

(b) Determine an accurate value for the distance *v*.

$V_1 = 30.0 - 15.1 = 14.9$ $\quad$ $\text{av } V = \frac{14.9 + 15.1}{2}$ [A1] $= 15.0$ cm [A1]

$V_2 = 30.0 - 14.9 = 15.1.$

- nearest sf (3sf)
- unit given.

*Penalise if no workings shown. Give 0

within 10.0 cm to 25.0 cm

v = 15.0 cm. [2] MNO

(c) Record your values of *u* and *v* in a table. Include a column for (*u* + *v*) and a column for *uv*.

For values of *u* from 15.0cm to 25.0 cm, determine corresponding values of *v*, (*u* + *v*) and *uv*. Record all of your measurements and calculations in your table.

u/cm	V_1/cm	V_2/cm	V_{ave}/cm	(u+v)/cm	uv/cm^2
15.0	14.9	15.1	15.0	30.0	225
17.0	13.3	13.3	13.3	30.3	226
19.0	12.0	12.5	12.3	31.3	234
21.0	11.4	11.6	11.5	32.5	242
23.0	10.4	10.8	10.6	33.6	244
25.0	10.4	10.6	10.5	35.5	263
1dp	1dp	1dp	least dp (1dp)	least dp (1dp)	least sf (3sf)

Range & Headings with units - A1

No. of readings - A1 (at least 5 readings)

Precision of V - A1

Calculation & Precision of (u+v) - A1

Calculation & Precision of uv - A1

u+v cannot be bigger than 50.0 cm.

(d) Using the grid provided, plot a graph of *uv* against (*u* + *v*). [4] PDO

(e) The gradient of your line of best fit is numerically equal to the focal length *f* of the combination of lenses.

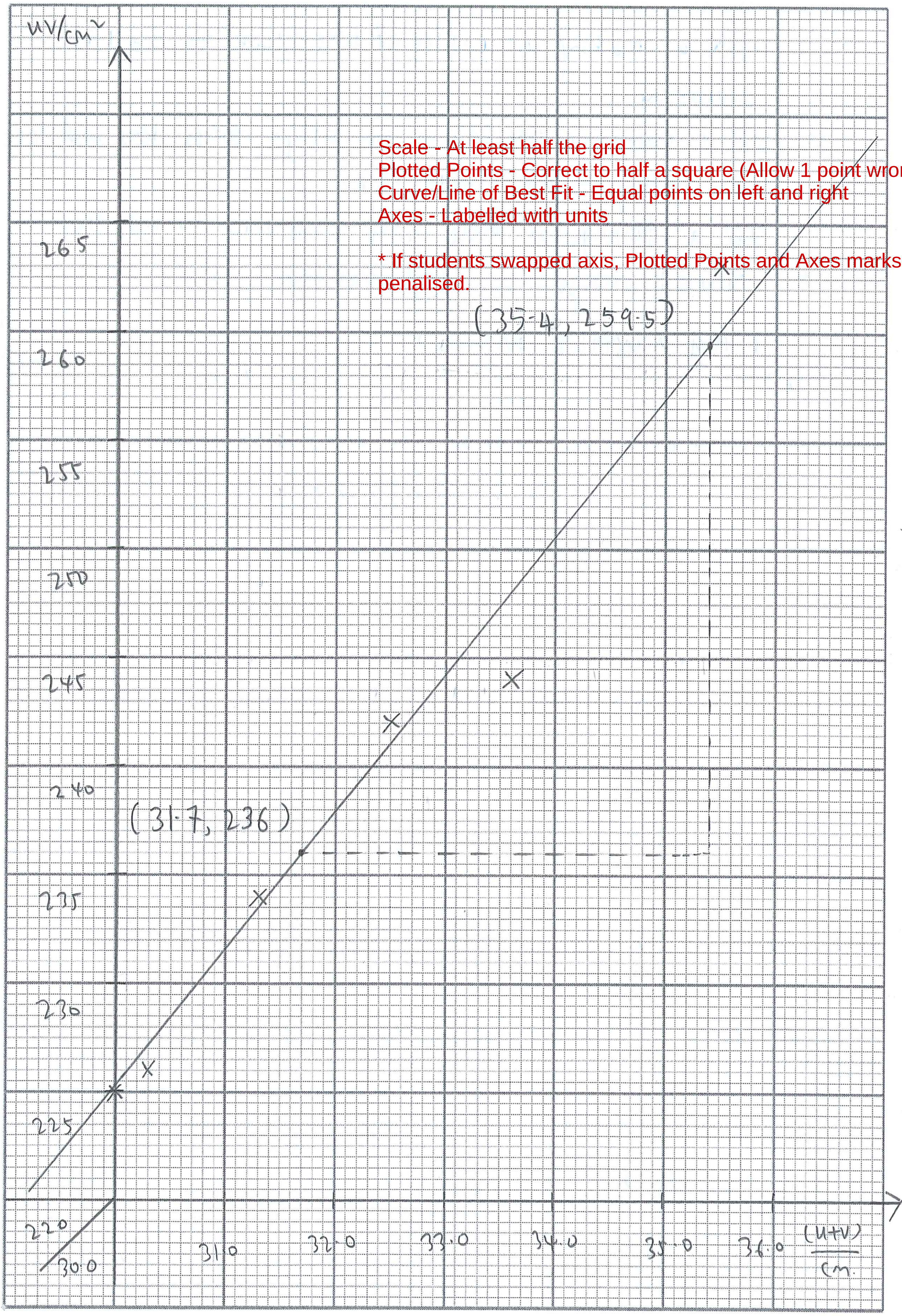
Determine *f*.

$$f = \frac{259.5 - 236}{35.4 - 31.7} = 6.35 \text{ cm (3sf)}$$

f = 6.35 cm. [2] ACE

*gradient triangle and coordinates must be shown on graph

- gradient working shown on graph [A1]
- gradient calculation shown & nearest sf with unit. [A1]



Scale - At least half the grid
Plotted Points - Correct to half a square (Allow 1 point wrong)
Curve/Line of Best Fit - Equal points on left and right
Axes - Labelled with units

* If students swapped axis, Plotted Points and Axes marks will be penalised.

(f) Describe **three** improvements to the experiment that reduce experimental error.

1 Mark a marking on centre of lens block to read it accurately. [A1]

2 Use a ruler or set square to align torch, lens and screen with reading of half metre rule. [A1]

3 Use a triangular hole with cross hair to observe focused image.  cross hair. [A1]

[3] ACE.

(any acceptable answers)

[Total: 20]

4 Secure the lenses using lens holders/glue

5 Ensure lens, screen and triangular card are perpendicular to bench using a set square/protractor

6 Use a single lens instead of two lenses

Reject

- conduct experiment in darker room
- repeat the experiment

[Blank Page]

[Blank Page]