



Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2026

Secondary 4 Express

CANDIDATE NAME	()	CLASS	
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CENTRE NUMBER	S				
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INDEX NUMBER				
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PHYSICS (G3)

6091/03

Paper 3 Practical

24 August 2026

1 hour 50 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class, class index number, centre number and O level index number on the cover page.

Give details of the practical shift and laboratory where appropriate, in the boxes provided.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, fasten all your work securely together, if applicable.

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

Shift
Laboratory

<i>For Examiner's Use</i>	
1	/10
2	/10
3	/20
Total	/40

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

You are provided with

- two 1.5 V cells with holders,
- an ammeter, a voltmeter, a switch,
- a resistance wire taped to a metre rule,
- an unknown resistor **Y**,
- 7 short connecting wires and 1 long wire labelled **G**,
- a digital micrometer screw gauge.

- (a) (i) Measure and record an accurate value of diameter d of the resistance wire taped to the metre rule.

$d =$ [2]

- (ii) Describe one precaution that you have taken when determining the diameter d of the resistance wire.

.....

..... [1]

- (b) Set up the circuit as shown in Fig. 1.1 with the switch open.

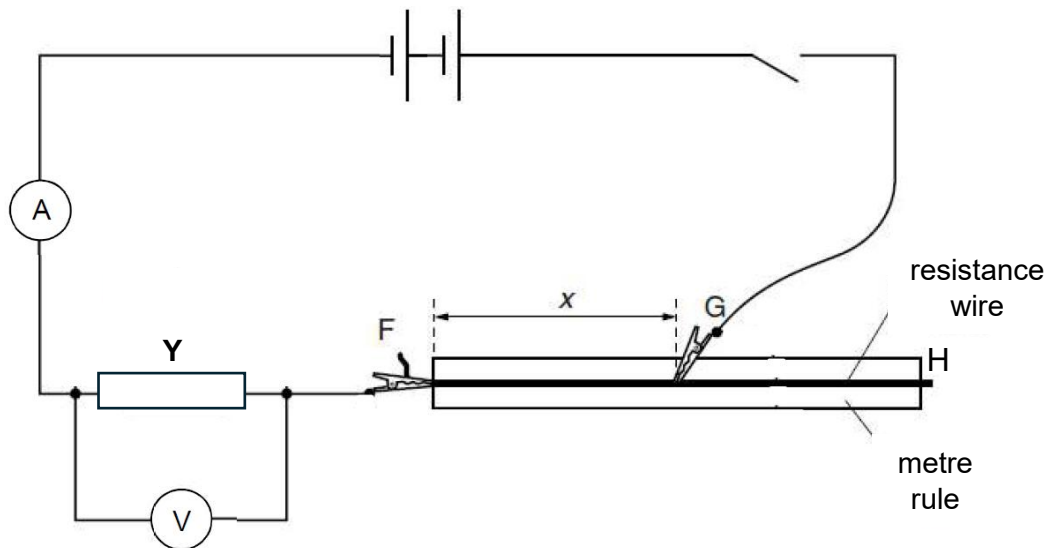


Fig. 1.1

There are two crocodile clips **F** and **G** that can be connected to the resistance wire. **F** will remain in the same position throughout the experiment. **G** can be moved.

- (c) (i) Attach **G** to the wire at a distance x about 50 cm from the end of the rule, as shown in Fig. 1.1.

Record the distance x .

$x =$ [1]

- (ii) Close the switch.

Record the ammeter reading I_1 and the voltmeter reading V_1 .

$$I_1 = \dots\dots\dots$$

$$V_1 = \dots\dots\dots [2]$$

Remove **G** from the wire and open the switch.

- (iii) Suggest one improvement that could be made to the measurement of x .

.....

..... [1]

- (d) (i) Use your measurements in (c)(ii) to determine R_1 , the value of resistance of **Y**.

$$R_1 = \dots\dots\dots [1]$$

- (ii) Attach **G** to point **H** of the wire shown in Fig. 1.1.

- (iii) Close the switch.

Record the ammeter reading I_2 and the voltmeter reading V_2 .

$$I_2 = \dots\dots\dots$$

$$V_2 = \dots\dots\dots [1]$$

- (iv) Determine R_2 , the value of resistance of **Y**.

$$R_2 = \dots\dots\dots$$

- (e) Your teacher claims R_1 and R_2 should be equal. Using appropriate calculations, prove whether your teacher is correct or wrong.

.....

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..... [1]

[Total: 10]

[Turn over

2 In this experiment, you will investigate the rate of energy transfer by light.

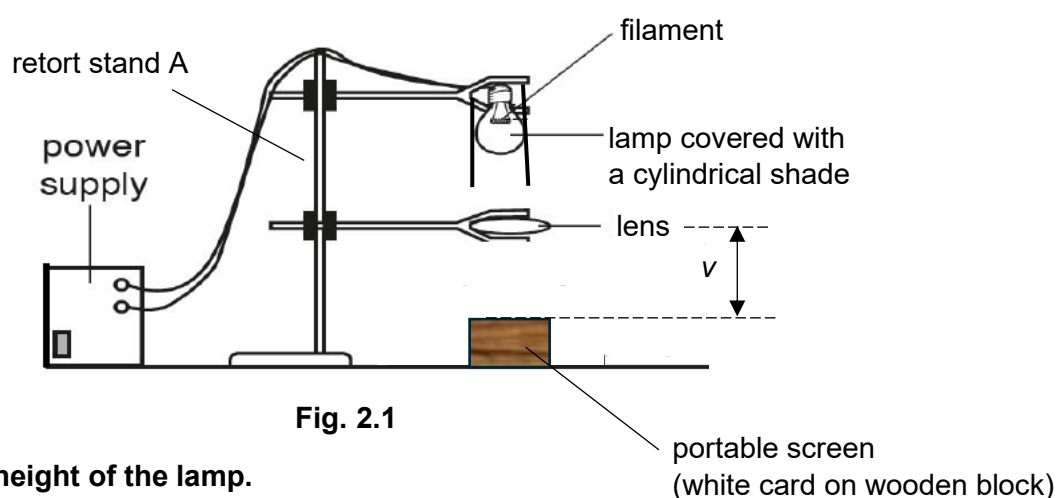
You are provided with

- retort stand A, 2 bosses, 2 clamps,
- a lamp secured to the retort stand A, connected to an AC power supply,
- retort stand B, 1 boss, 1 clamp,
- a thin converging lens,
- a portable screen made from a piece of white card pasted on a wooden block,
- a stopwatch, a thermometer,
- a half-meter rule, a 15-cm ruler.

SAFETY

The lamp is HOT!
Do not touch the lamp.

Set up the apparatus as shown in Fig. 2.1.



Do not adjust the height of the lamp.
Switch on the power supply.

- (a) Adjust the height of the clamp holding the lens until the smallest bright spot is formed on the portable screen. The bright spot is the sharply focused image of the filament of the lamp.

Measure the distance v from the centre of lens to the portable screen.

$v = \dots\dots\dots$

- (b) Measure and record the room temperature T_R .

$T_R = \dots\dots\dots$

- (c) Power rating of the lamp is 60 W.

Calculate the amount of energy E provided to the lamp in 3.0 minutes.

$E = \dots\dots\dots$ [1]

Position the thermometer clamped to retort stand B as shown in Fig. 2.2 such that the bulb rests on the portable screen.

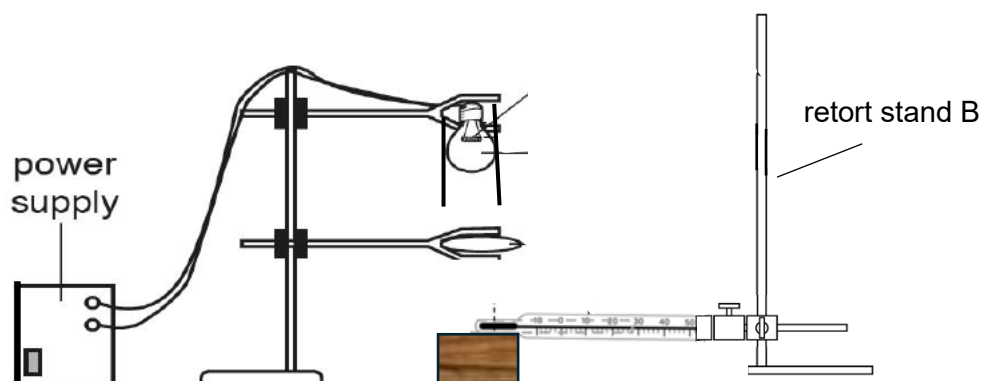


Fig. 2.2

Position the thermometer such that the light rays from the lamp converge at the center of the bulb of the thermometer.

Start the stopwatch.

- (d) After 3.0 minutes, measure and record the temperature on the thermometer T_H .

$T_H = \dots\dots\dots$ [1]

- (e) The thermometer uses alcohol to measure temperature. Suggest a reason for the difference between T_H and T_R .

.....

[1]

- (f) Describe a modification to the thermometer so that the time taken for the final temperature reading to be reached is reduced.

.....

[1]

- (g) A student suggests that the $T_H - T_R = av^2 + b$, where a and b are constants and v is the distance between the optical centre of the lens and the bulb of the thermometer.

Using the same apparatus, plan an experiment to investigate this relationship.

In your plan, you should:

- describe briefly how to set up the experiment
- draw a table, with column headings, with correct units
- explain how to determine a and b if the student's claim is correct.

[illegible]

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..... [6]

[Total: 10]

[Turn over

- 3 In this experiment, a wooden cylinder is suspended from a length of string. The cylinder will be rotated.

You have been provided with

- a retort stand, boss and clamp,
- a piece of string tied to the middle of the small hollow cylinder,
- a metre rule,
- a 30 cm ruler,
- two wooden blocks,
- a stopwatch,
- a digital caliper.

- (a) Set up the apparatus as shown in Fig. 3.1 such that the wooden cylinder is free to rotate.

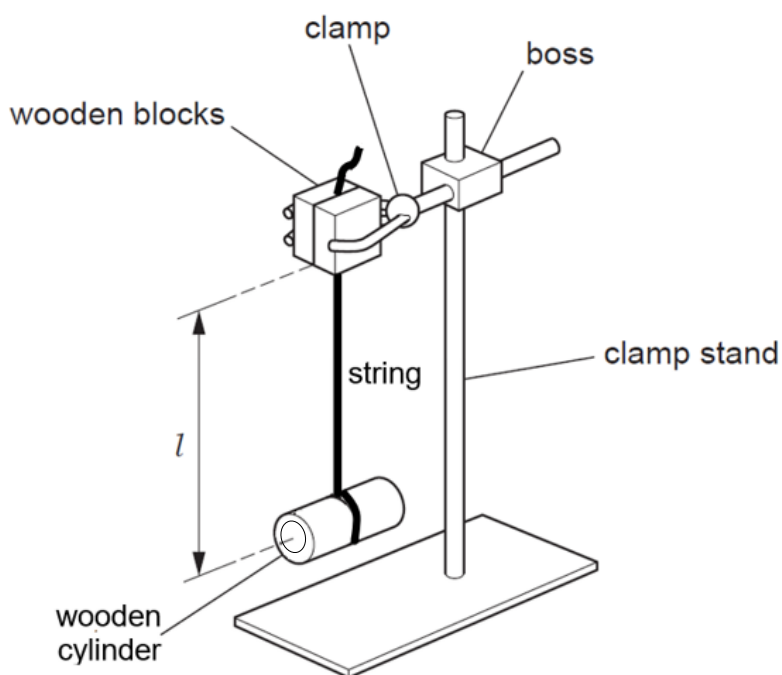


Fig. 3.1

- (b) (i) Length l is the distance from the point of suspension to the mid-point of the cylinder's cross-sectional area. Adjust the length l to be about 40 cm. Measure and record l .

$l = \dots\dots\dots$ [1]

- (ii) Measure and record the internal diameter, D , of the wooden cylinder.

$D = \dots\dots\dots$ [1]

- (c) Keeping the string taut and the cylinder horizontal, turn the cylinder through **ten** complete turns in order to twist the string, as shown in Fig. 3.2.

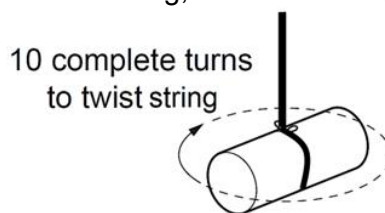


Fig. 3.2

When you release the cylinder, the string will untwist and then twist again, before coming to rest momentarily. It will then untwist in the other direction.

Release the cylinder, and measure and record a reading of time taken, τ for the cylinder to come to rest momentarily for the **first** time.

$\tau = \dots\dots\dots$ [1]

- (d) Change l and repeat the procedures in (b) and (c).

For each value of l , calculate $\sqrt{l}$. l should be at least 20 cm.

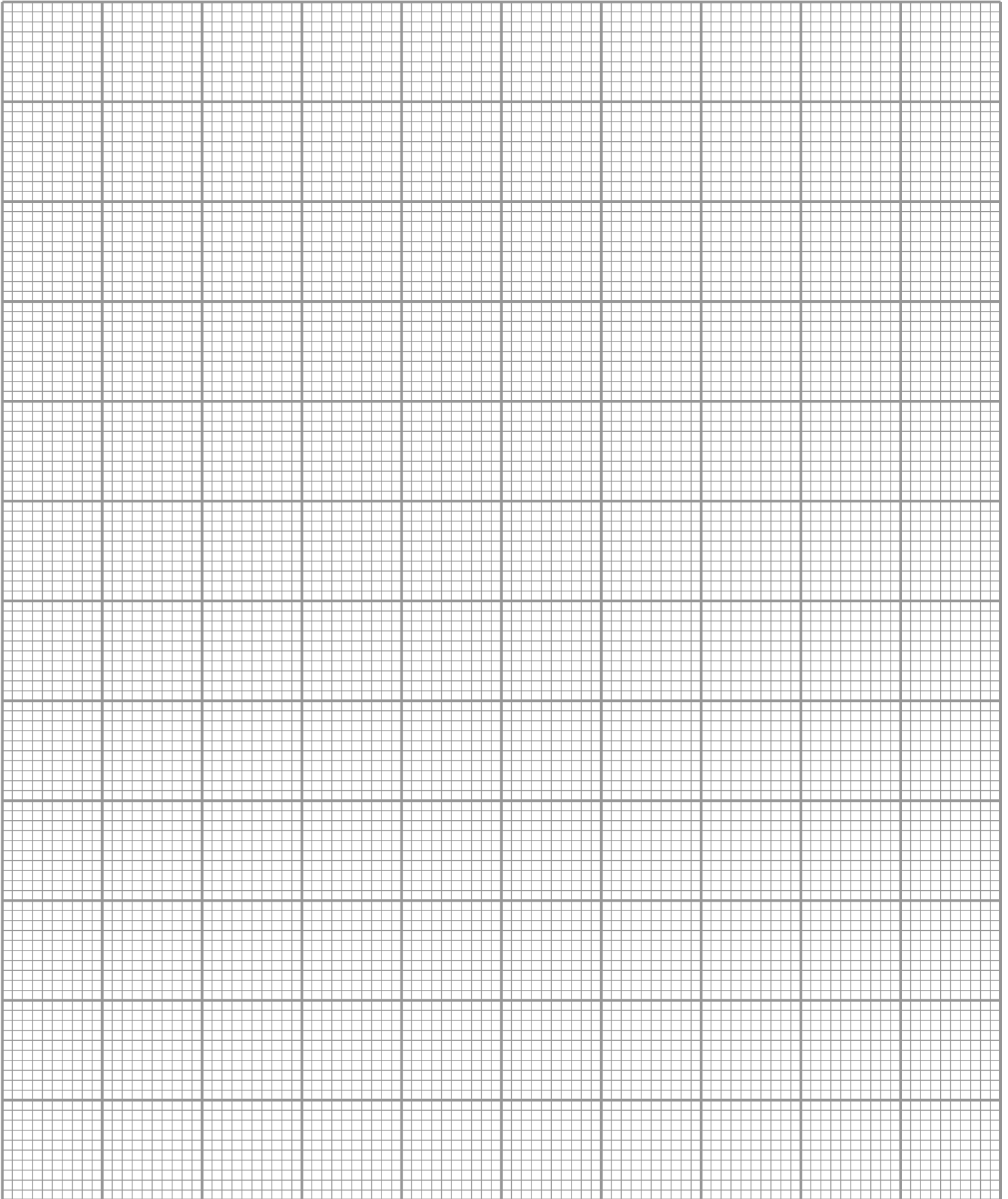
Record all measurements and calculations in a suitable table.

Include the value of τ from (c), for the value of l from (b)(i).

[6]

- (e) Plot a graph of τ against $\sqrt{l}$ on the gridlines provided on the next page. [4]

[Turn Over



- (f) It is known that $\tau = G\sqrt{l} + c$
Calculate the gradient of the graph and hence determine G .

$G = \dots\dots\dots$ [3]

- (g) Determine the y-intercept Y of the line of best fit.

$Y = \dots\dots\dots$ [2]

- (h) Describe one source of error in the experiment.
Suggest one improvement to reduce this error.

source of error

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.....
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improvement

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.....
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[2]

End of Paper

[Total: 20]

Mark Scheme

1	ai	Measure and record an accurate value of diameter d of the resistance wire taped to the metre rule. $d = \dots\dots\dots$ [2]	$d = 0.300$ to 0.380 mm	Answer must be in 3 d.p or 2 d.p in mm Or equivalent in cm; within range Evidence of taking average	MMO	1 1
	a ii	Describe one precaution that you have taken when determining the diameter d of the resistance wire.  $\dots\dots\dots$ $\dots\dots\dots$ [1]	- use the ratchet to prevent over-tightening OR - Check for zero error.	Either answer or any other reasonable precaution	ACE	1
	ci	Attach G to the wire at a distance $x = 50$ cm from the end of the rule, as shown in Fig. 1.1. Record the distance x . $x = \dots\dots\dots$ [1]	$x = 49.0$ to 51.0 cm	1 d.p in cm	MMO	1
	c ii	Close the switch. Record the ammeter reading I_1 and the voltmeter reading V_1 . $I_1 = \dots\dots\dots$ $V_1 = \dots\dots\dots$ [2]	$I_1 = 0.14$ to 0.16 A $V_1 = 1.20$ - 1.40 V	Both measurements in 2 d.p Correct units provided	MMO PDO	1 1
	c iii	Explain one improvement that could be made to the measurement of x . $\dots\dots\dots$ $\dots\dots\dots$ [1]	Replace the crocodile clip at G with a jockey which has a sharp/flat end that can be placed at the ruler marking accurately.	Do not accept 'replace G with a jockey' as this is not an explanation.	ACE	1
	di		$R_1 = V_1 \div I_1 = 8.0$ to 11Ω	Answer is within range ; appropriate s.f	ACE	1
	d iii		$I_2 =$ $V_2 =$	Do not mark for units or d.p $I_2 < I_1$ $V_2 < V_1$	MMO	1
	div		$R_2 = V_2/I_2$	Not a marking point R_2 should be close to R_1		

		(i) Use your measurements in (c)(ii) to determine R_1, the value of resistance of Y. $R_1 = \dots\dots\dots$ [1] (ii) Attach G to the wire at a distance $x = 100$ cm. (iii) Close the switch. Record the ammeter reading I_2 and the voltmeter reading V_2. $I_2 = \dots\dots\dots$ $V_2 = \dots\dots\dots$ [1] (iv) Determine R_2, the value of resistance of Y. $R_2 = \dots\dots\dots$				
	e	Your teacher claims R_1 and R_2 should be equal. Using appropriate calculations, prove whether your teacher is correct or wrong. $\frac{ R_1 - R_2 }{R_1} \times 100\%$	Yes, because percentage difference between R_1 and R_2 (show calculations) is xxx, which is small (less than 5%) No, because percentage difference between R_1 and R_2 (show calculations) is xxx, which is considerable (more than 5%).	A claim supported by evidence provided by the % difference.	ACE	1

Q2 Mark Scheme

2	a	Adjust the height of the clamp holding the lens until the smallest bright spot is formed on the sheet of paper. The bright spot is the sharply focused image of the filament of the lamp.	v is about 14 cm	Not marking point		
	b	Measure the distance v from the <u>centre</u> of lens to the paper. $v = \dots\dots\dots$ Clamp the thermometer on retort stand B to measure and record the room temperature T_R . $T_R = \dots\dots\dots$	$T_R = 31$ to $33\text{ }^{\circ}\text{C}$	Not marking point		
	c	Take note of the power rating on the power supply. Hence calculate the amount of energy E provided to the lamp in 3 minutes. $E = \dots\dots\dots$	$E = P \times t$ $= 60 \times 3.0 \times 60 = 108\,00 = 11\,000\text{ J}$	E is calculated correctly to <u>appr sf</u> and in J	ACE	1
	d	After 3 minutes, measure and record the temperature on the thermometer T_H . $T_H = \dots\dots\dots$	$T_H =$	T_H is measured to <u>1 dp</u> in <u>$^{\circ}\text{C}$</u> . T_H must be higher than T_R	MMO	1
	e	(e) The thermometer uses alcohol to measure temperature. Suggest a reason for the difference between T_H and T_R If students explain the small difference between T_H and T_R : - Not all light energy from the lamp reaches the thermometer as light rays travel in all directions. - Energy that reaches the thermometer is not totally absorbed by the alcohol in the bulb. - The thermometer is not precise enough to measure small changes in temperature.	If students explain why T_H is different from T_R : Energy is transferred via light waves from the lamp to the internal store of the thermometer, causing a rise in temperature, T_H .	Any other reasonable explanation Many students thought that air around thermometer is heated up by the light and hence a higher temp in thermometer	ACE	1

f	(f) Describe a modification to the thermometer so that the time taken for the final temperature reading to be reached is reduced. Using a lamp with higher power rating only raise the final temp reached by the thermometer. It does not reduce the time taken. Place thermometer in ice bath?? Move the thermometer closer to the lamp is wrong	Suggests to use a medium (like mercury) of a lower specific heat capacity OR Use a thermometer with thin <u>bulb</u> walls OR Paint the thermometer <u>bulb</u> black OR Use a smaller bulb OR Replace alcohol with mercury which is a better conductor.	Any other reasonable explanation	ACE	1
g	A student suggests that the $T_H - T_R = av^2 + b$, where a and b are constants and v is the distance between the optical centre of the lens and the bulb of the thermometer. Using the same apparatus, plan an experiment to investigate this relationship. In your plan, you should: - explain briefly how to the experiment - draw a table, with column headings, to show how to display the range of headings - explain how to determine a and b if the student's claim is correct.	IV is v, the dist from the centre of lens to the focused image / (thermometer bulb); DV is T_H or $T_H - T_R$ CV is the position of the lamp / power of the supply	Identify D.V, I.V and C.V (one C.V suffices)	P1	1
		Adjust the position of the clamp holding the lens until a focused image is formed on the screen placed on the bench. Using a ruler, measure the distance between the optical centre of lens to the screen which is v. place the thermometer bulb at the position of the focused image and measure T_H. Move the lens to change the distance between the lens and the lamp. Find the new v by moving the screen vertically to and away from the lens until a focused image is obtained. repeat this until 6 sets of v are obtained.	Description of set-up for the first measurement of v and describe how v and T_H are determined Describe how v is varied	P2 P3	1 1

				Describe one precaution for accuracy	P4	1								
			Tabulate 6 sets of readings of v/cm, $T_H - T_R/^{\circ}\text{C}$ and v^2/cm^2 <table><tr><td>v/cm</td><td>$T_H/^{\circ}\text{C}$</td><td>$T_H - T_R/^{\circ}\text{C}$</td><td>$v^2/\text{cm}^2$</td></tr><tr><td></td><td></td><td></td><td></td></tr></table>	v/cm	$T_H/^{\circ}\text{C}$	$T_H - T_R/^{\circ}\text{C}$	v^2/cm^2					Table with correct column headings	P5	1
v/cm	$T_H/^{\circ}\text{C}$	$T_H - T_R/^{\circ}\text{C}$	v^2/cm^2											
			Draw a best-fit straight line of $T_H - T_R$ against v^2, a is the gradient of the graph and b is the vertical intercept	If graph is sketched, the graph should start from (0, 0)	P6	1								

Q3 Mark Scheme

3	bi	Length l is the distance from the point of suspension to the mid-point of the wooden cylinder's cross-sectional area. Adjust the length l to be about 40 cm. Measure and record l . $l = \dots\dots\dots$ [1]	l is about 40 cm and recorded to the 0.1 cm		PDO	1
	bii	Measure and record the diameter, D , of the wooden cylinder. $D = \dots\dots\dots$ [1]	$D = 3.600$ to 3.700 cm (2 dp or 3 dp in cm)		MMO	1
	C	Release the cylinder, and measure and record a reading of time taken, τ for the cylinder to come to rest momentarily for the first time. $\tau = \dots\dots\dots$ [1]	τ is within range 12.5 to 13.0 s	DO not mark for units and d.p which are done so in Table	MMO	1
	d	Change l and repeat the procedures in (b) and (c). For each value of l , calculate $\sqrt{l}$. Record all measurements and calculations in a suitable table. Include the value of τ from (c), for the value of l from (a)(i).	M1 – at least 6 sets of readings M2 Table headings with units M3 $\sqrt{l}$ calculated correctly to same s.f. as l M4 l to 1 dp in cm M5 τ to 1 dp or 2 dp in s M6 range of l is at least 40 cm	M4 is not penalised again if 3bi is not awarded due to dp as long as candidate in consistent in the dp	MMO PDO ACE PDO PDO MMO	1 1 1 1 1 1

e	Plot a graph of t against $\sqrt{l}$ on the gridlines provided on the next page.	Axes labelled with units and correct orientation (allow ecf from wrong unit in table but not no units) Scale Suitable scale with plotted points occupying at least half the page in both directions Plot All points plotted correctly (points must be within $\frac{1}{2}$ small square from the correct position) Best Fit Best fit line and fine crosses		PDO	4
f	It is known that $t = G\sqrt{l} + c$ Calculate the gradient of the graph and hence determine G. $G = \dots\dots\dots$ [2]	Gradient Use of a gradient triangle that uses more than half the drawn line, coordinates shown on graph, with Clear working with substitution shown Final answer G is determined accurately, within the range (1.50 to 2.30) G is presented to the appropriate sf with correct units ($\text{s/cm}^{1/2}$)		ACE MMO PDO	1 1 1
g	Determine the y-intercept Y of the line of best fit. $Y = \dots\dots\dots$ [1]	If read off the graph, Y is presented to $\frac{1}{2}$ the smallest sq with correct units (s) If calculated, Y is presented to appr s.f with correct units (s)		ACE	1

	h	Describe one source of error in the experiment. Suggest one improvement to reduce this error. source of error improvement 	Source of error 1: The ruler cannot be in contact with the base of the wooden blocks which will contribute to parallax error in l. Improvement 1: Place a pointer (a long pin or a straw) at the base on the wooden block. Source of error 2: It is difficult to determine the centre of the cylinder as it is hollow. Improvement 2: The procedure should require measurement of the external diameter of the cylinder. l can then be determined from the length of the string + external radius of cylinder. Source of error 3 Error due to human reaction time is not accounted for. Improvement 3 The procedure should require measurement of two values of τ so as to calculate an average value of τ.		ACE	2
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MMO 10 marks

PDO 10 marks

ACE 14 marks

Planning 6 marks