

Name:.....

Register/Index Number:

Class:

PRESBYTERIAN HIGH SCHOOL



PHYSICS

6091/3

Paper 3

21 August 2026

Friday

1 hour 50 minutes

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2026 SECONDARY FOUR EXPRESS PRELIMINARY EXAMINATION

Instructions to students:

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

Write in dark blue or black pen in the spaces provided on the Question paper.
You may use a pencil for any diagrams, graphs or rough work.

READ THESE INSTRUCTIONS FIRST

*Write your name, class register number and class in the spaces at the top of this page.
Write in dark blue or black pen. You may use an HB pencil for any diagrams or graphs. Do not use
staples, paper clips, glue or correction fluid.*

Answer **all** questions.

*All of your answers should be written in this Question Paper: scrap paper must **not** be used.
Graph paper is provided in this Question Paper. Additional sheets of graph paper should be used only
if it is necessary to do so.*

*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. An account of the method
of carrying out the experiments is **not** required. The use of an approved scientific calculator is
expected, where appropriate.*

*At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question
or part question.*

For Examiner's Use	
1	/10
2	/10
3	/20
Total	

This question paper consists of **11** printed pages

[Turn over

1 *In this experiment, you will investigate the mass and volume of a dry cell.*

You are provided with:

- a dry cell
- a ruler
- two set squares
- an electronic balance.

- (a) (i)** Describe one precaution you must take before measuring the mass of the dry cell using an electronic balance.

.....
[1]

- (ii)** Measure and record the mass of the dry cell.

mass = [1]

- (b) (i)** Draw a labelled diagram to show how to use the ruler and the set squares to measure the diameter of the dry cell.

- (ii)** Measure and record the diameter d of the dry cell. [2]

d = [1]

- (c) (i) Measure and record the total length l of the dry cell, as shown in Fig. 1.1.

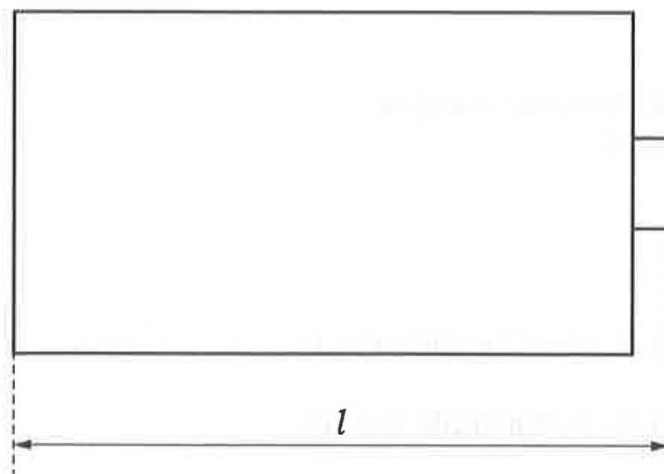


Fig. 1.1 (not to scale)

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

- (ii) Estimate the volume V of the dry cell using the equation

$$V = \frac{\pi}{4} ld^2$$

$V = \dots\dots\dots$ [1]

- (iii) The volume calculated in (c)(ii) is an estimate of the volume of the dry cell.

Explain why it is only an estimate and why it is a good estimate of the actual volume of the dry cell.

.....

[2]

- (iv) Describe how the method for determining the volume of the dry cell may be improved.

.....

[1]

2 *In this experiment, you will investigate the motion of a mass on a piece of wire.*

You are provided with

- a piece of wire
- two crocodile clips
- a rule
- a stop-watch
- a boss and a stand.

(a) Place one end of the piece of wire in the jaws of one of the crocodile clips.

Attach the crocodile clip to the boss and attach the boss to the stand, as shown in Fig. 2.1.

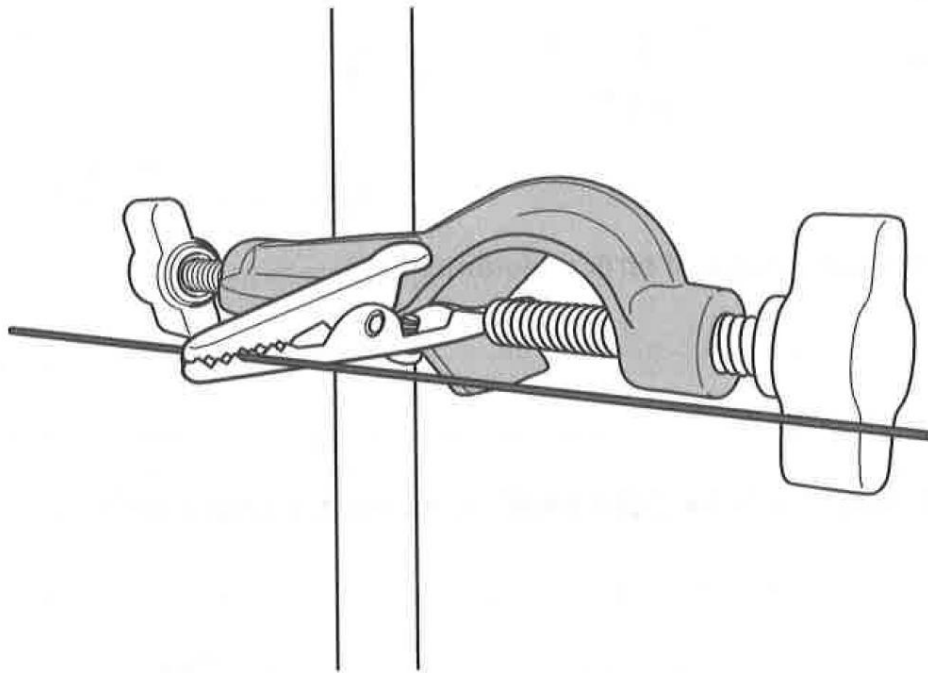


Fig. 2.1

Adjust the boss until the height h of the free end of the wire is approximately 30 cm above the bench, as shown in Fig. 2.2.

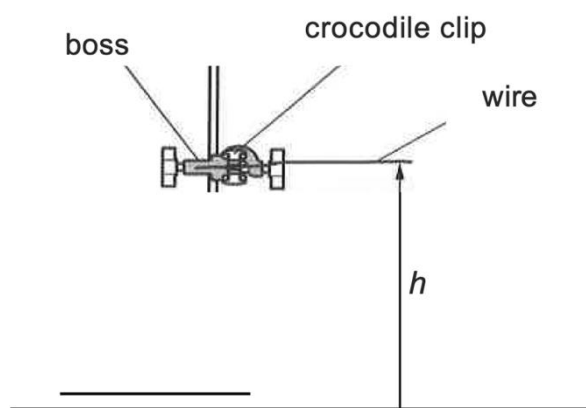


Fig. 2.2

- (i) Measure and record h .

$h = \dots\dots\dots$ [1]

- (ii) Attach the second crocodile clip to the free end of the wire, as shown in Fig. 2.3.

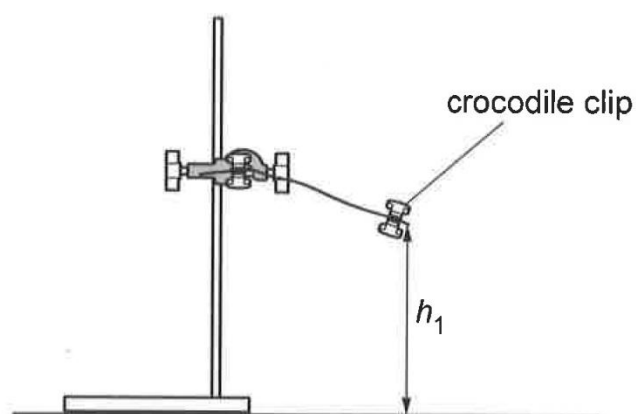


Fig. 2.3

Measure and record h_1 .

$h_1 = \dots\dots\dots$

Calculate the deflection y of the wire, where $y = h - h_1$.

$y = \dots\dots\dots$ [1]

- (b) Push the free end of the wire down a small distance and then release it. The wire oscillates.

Determine the period T of oscillation of the wire.

$T = \dots\dots\dots$ [2]

[Turn over

- (c)** A student claims that $T = a\sqrt{y} + b$, where a and b are constants and y is the deflection of the wire.

Plan an experiment to investigate the student's claim. In your plan, you should:

- explain briefly how to do the experiment
- 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.

[illegible]

3 *In this experiment, you will investigate combinations of resistors in an electrical circuit.*

You are provided with

- a battery
- a resistor X
- an ammeter
- a voltmeter
- a switch
- connecting leads
- two 3.3Q resistors
- two 10 Q resistors.

Assemble the apparatus as shown in Fig. 3.1.

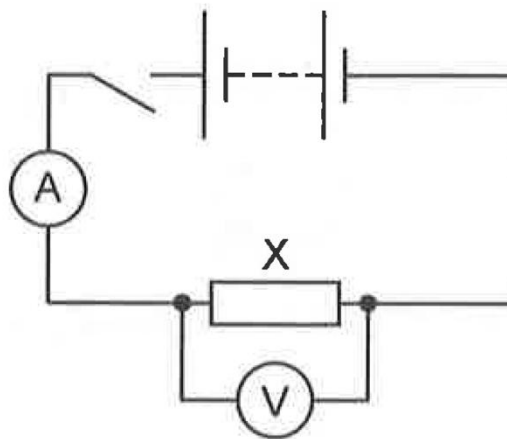


Fig. 3.1

(a) (i) Record

- the voltmeter reading V
- the ammeter reading I

$V = \dots\dots\dots$

$I = \dots\dots\dots$

Open the switch immediately after taking the readings.

[2]

(ii) Calculate the resistance R_X of resistor X using the equation $R_X = \frac{V}{I}$.

$R_X = \dots\dots\dots$ [1]

[Turn over

(b) The resistors can be connected:

- in parallel, as shown in Fig. 3.2
- in series, as shown in Fig. 3.3.

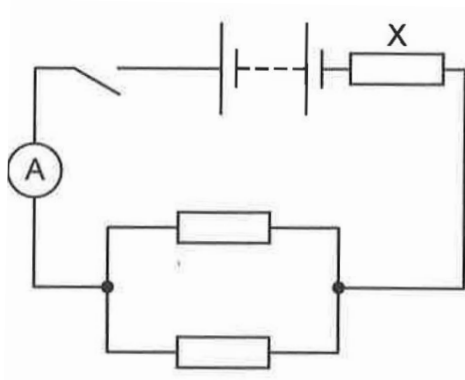


Fig. 3.1

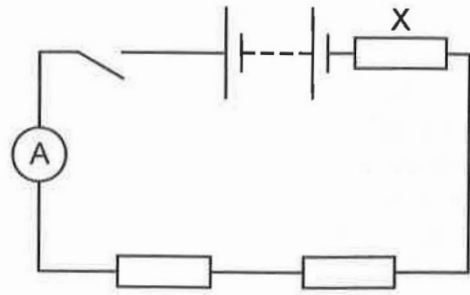


Fig. 3.2

For a **parallel** combination of resistors of resistance R_1 and R_2 , the effective resistance, R_E is

$$R_E = \frac{R_1 \times R_2}{R_1 + R_2}$$

For a **series** combination of resistors of resistance R_1 and R_2 , the combined resistance, R_E is

$$R_E = R_1 + R_2$$

Make **six** circuits with different combined resistances, each using two of the four resistors in different combinations.

For each combination of resistors,

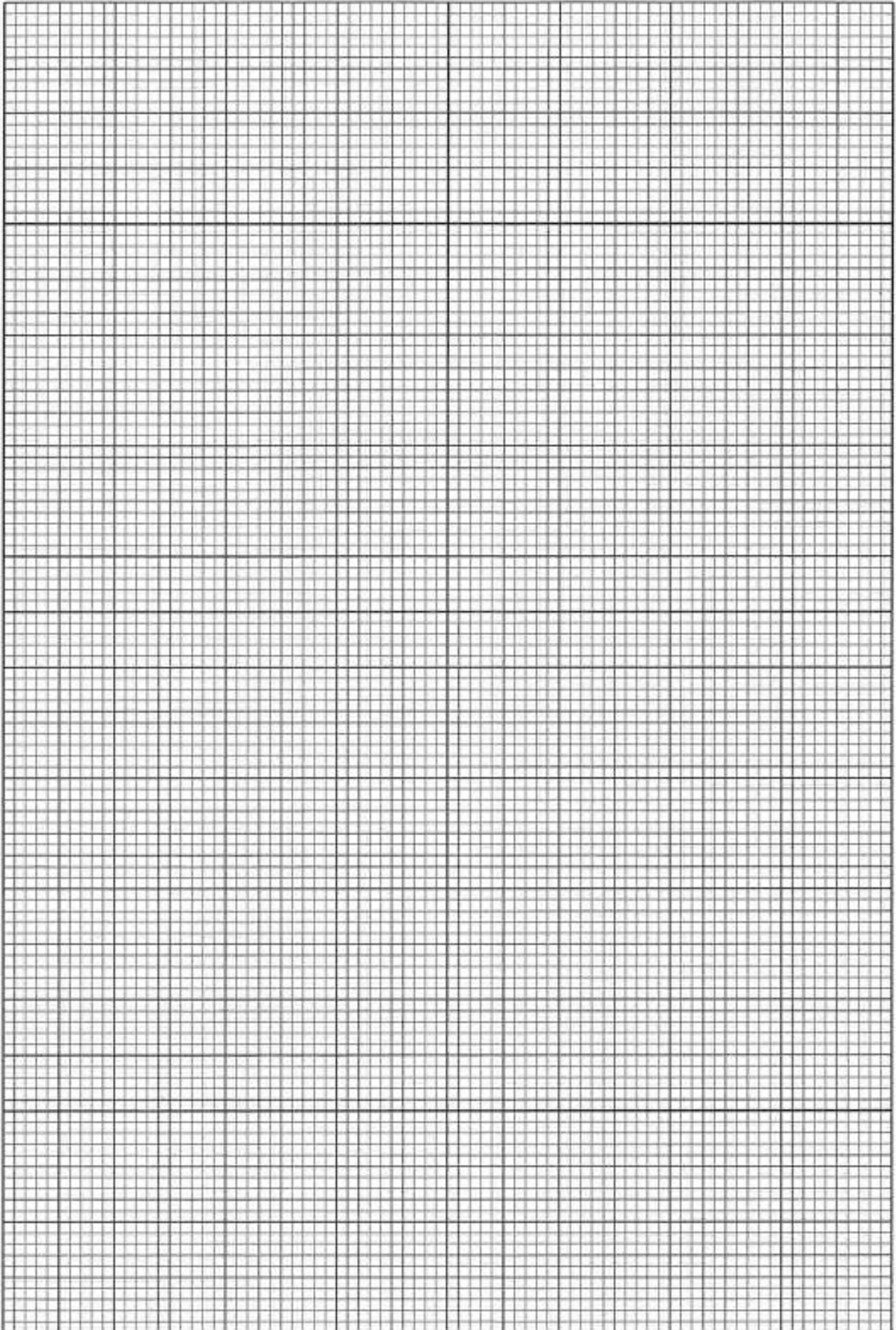
- calculate the effective resistance, R_E
- measure I and calculate $\frac{1}{I}$;

Record all of your measurements and calculations in a suitable table.

[7]

- (c) (i) On the grid provided, plot a graph of $\frac{1}{I}$ against R_E . Start the x-axis at $R = 0$. [4]

[Turn over



(ii) Determine the gradient G of the line of best fit.

$G = \dots\dots\dots$ [2]

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

$Y = \dots\dots\dots$ [1]

(d) (i) A student suggests that $R_X = \frac{Y}{G}$

Use your values of G and Y to calculate another value for the resistance R_X of resistor X using this equation.

$R_X = \dots\dots\dots$ [1]

(ii) Describe **one** source of error that results in different values of R_X in (a)(ii) and (d)(i).

Suggest **one** improvement to reduce this error.

source of error

.....

improvement

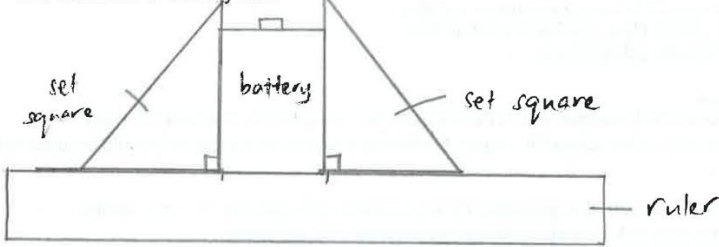
.....

[2]

END OF PAPER

[Turn over

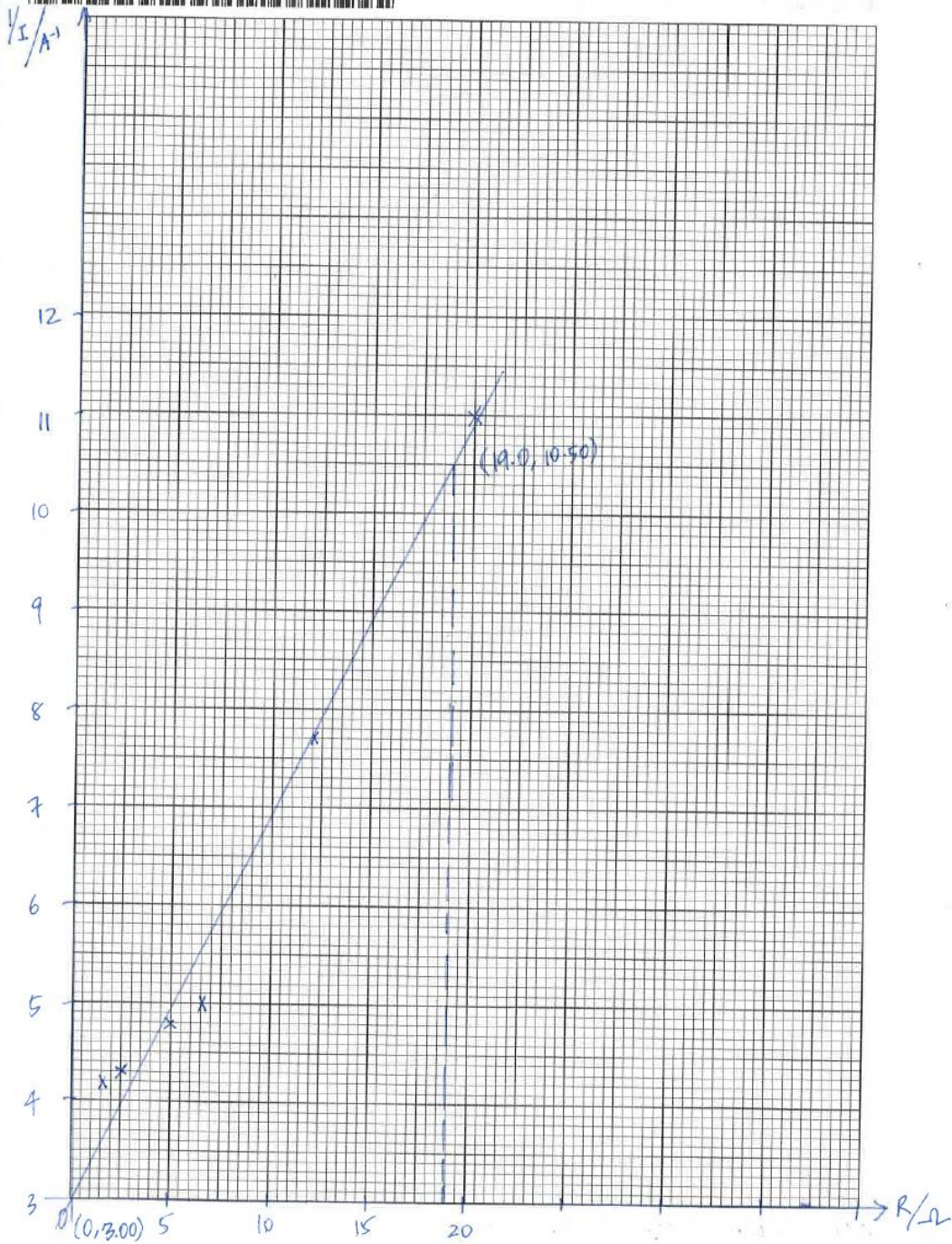
Suggested Mark Scheme:

Q1	Marking Instructions	Mark
ai	Tare the electronic balance to reset the display to zero.	A1
ii	MMO 90.5 g reasonable value of mass (90.4 g – 90.6 g) correct precision and unit	A1
bi		M1 B1
ii	MMO 3.2 cm correct precision and unit	A1
ci	MMO $l = 6.1 \text{ cm}$ reasonable value of l (6.1 cm to 6.3 cm) correct precision and unit	A1
ii	$V = 49 \text{ cm}^3$ correct s.f and calculation	A1
iii	It is an estimate since length l includes air spaces. It is a good estimate since the volume of the tip at the positive terminal is very small compared to the whole cell.	B1 B1
iv	Use a digital calipers to measure lengths instead of ruler. Use its external jaws to clamp the cell.	B1
	Total	10

Q2	Marking Instructions	Mark																																																								
bi	MMO 30.0 cm reasonable value of h (29.8 cm to 30.2 cm) correct precision and unit	A1																																																								
ii	$h_1 = 23.5 \text{ cm}$ $y = 6.5 \text{ cm}$ reasonable value of y (4.0 cm to 10.0 cm) correct precision and unit	A1																																																								
b	average time for 20 oscillations = $\frac{8.1 + 8.3}{2} = 8.2 \text{ s}$ Period , $T = \frac{8.2}{20} = 0.41 \text{ s}$ (2 s.f) - Evidence of timing at least 5 oscillations. - Evidence of repeated measurements (e.g., two trials and averaging).	M1 A1																																																								
c	(i) Variables - One relevant variable kept constant, e.g.: - type or length of wire - mass of crocodile clips (ii) Method to vary y - Vary y by changing the distance between the two crocodile clips. <i>(Accept varying mass of crocodile clips to change y values, though less practical.)</i> (iii) Data collection procedure - Obtain at least four additional sets of h_1 and y. - Measure the period, T—time for several oscillations and divide by number of oscillations. (iv) Table <table><tr><th>d/cm</th><th>h_1/cm</th><th>y/cm</th><th>t_1/s</th><th>t_2/s</th><th>t_{ave}/s</th><th>T/s</th><th>$\sqrt{y}/\sqrt{\text{cm}}$</th></tr><tr><td>9.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>8.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>7.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>6.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>4.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>	d/cm	h_1/cm	y/cm	t_1/s	t_2/s	t_{ave}/s	T/s	$\sqrt{y}/\sqrt{\text{cm}}$	9.0								8.0								7.0								6.0								5.0								4.0								B1 B1 B1 B1
d/cm	h_1/cm	y/cm	t_1/s	t_2/s	t_{ave}/s	T/s	$\sqrt{y}/\sqrt{\text{cm}}$																																																			
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	(v) Graph plot a graph of T against $\sqrt{y}$	B1
	(vi) Graph analysis Gradient = a and vertical intercept = b identified from graph.	B1

Q3	Marking Instructions	Mark																					
ai	MMO V = 3.00 V. ($\pm 15\%$ of teacher's values) I = 0.29 A Correct precision with unit	A1 A1																					
ii	10 Ω (s.f rule)	A1																					
b	<table border="1"> <thead> <tr> <th>R_E/Ω</th><th>I/A</th><th>$1/I/ A^{-1}$</th></tr> </thead> <tbody> <tr> <td>6.6</td><td>0.20</td><td>5.0</td></tr> <tr> <td>20</td><td>0.09</td><td>11</td></tr> <tr> <td>13.3</td><td>0.13</td><td>7.7</td></tr> <tr> <td>1.65</td><td>0.24</td><td>4.2</td></tr> <tr> <td>5.00</td><td>0.21</td><td>4.8</td></tr> <tr> <td>2.48</td><td>0.23</td><td>4.3</td></tr> </tbody> </table> At least 6 different values for R_E Correct heading, (R/Ω , I/A and $1/I/ A^{-1}$) Correct precision for current reading Correct trend $R \uparrow$ and current $\downarrow$ Correct calculation of $1/I$ Correct sf for $1/I$	R_E/Ω	I/A	$1/I/ A^{-1}$	6.6	0.20	5.0	20	0.09	11	13.3	0.13	7.7	1.65	0.24	4.2	5.00	0.21	4.8	2.48	0.23	4.3	B1 B1 B1 B1 B1 B1 B1
R_E/Ω	I/A	$1/I/ A^{-1}$																					
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5.00	0.21	4.8																					
2.48	0.23	4.3																					

cii		
cii	$G = \frac{10.50 - 3.00}{19.0 - 0.0} = 0.395$	M1 A1
iii	$Y = 3.00$	A1
di	$R_x = \frac{3.00}{0.395} = 7.59 \, \Omega$	A1
ii	Error: Additional resistance from additional connection leads and contact points. Improvement: Ensure clean, tight electrical contacts. Error: Labelled resistor value may differ from actual value. Improvement: Measure resistance with a multimeter before use.	B1 B1

	Error: Internal resistance of battery reduces measured current. Improvement: Use batteries connected in parallel to reduce effective internal resistance.	
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Planning answer :

Variables

Independent variable:

Distance, d , between the two crocodile clips along the wire, which changes h_1 and hence the deflection y .

Dependent variable:

Period, T , of oscillation.

Controlled variables:

Type of wire, length of wire, and mass of the crocodile clip.

Method

1. Set up the apparatus as shown in Fig. 2.2 and Fig. 2.3.
2. Measure and record the height h of the free end of the wire before attaching the second crocodile clip.
3. Attach the second crocodile clip to the wire at a chosen distance d from the fixed crocodile clip.
4. Measure and record the new height h_1 . Calculate the deflection of the wire using

$$y = h - h_1$$

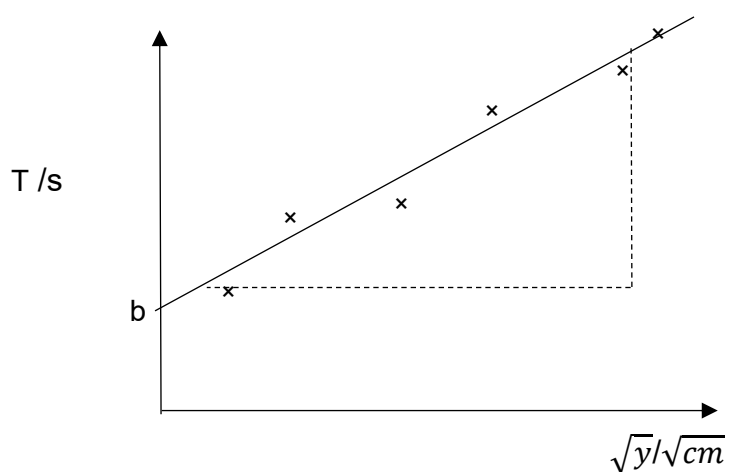
5. Push the free end of the wire down by a small distance and release it so that it oscillates.
6. Use a stopwatch to measure the time, t , for **10 complete oscillations**.
7. Repeat the timing for 10 oscillations and calculate the **average time**, t_{ave} .
8. Calculate the period using

$$T = \frac{t_{ave}}{10}$$

9. Change the distance d between the two crocodile clips along the wire. This changes h_1 and hence produces a different value of y .
10. Repeat steps 3 to 8 for **at least five different values of d** , obtaining the corresponding values of h_1 , y , and T .
11. Tabulate all the measured and calculated quantities.

d/cm	h_1 /cm	y/cm	t_1 /s	t_2 /s	t_{ave} /s	T/s	$\sqrt{y}/\sqrt{cm}$
9.0							
8.0							
7.0							
6.0							
5.0							
4.0							

Plot a graph of T against $\sqrt{y}$



Draw a best fit line through the plotted points.

gradient = a and **vertical intercept = b**