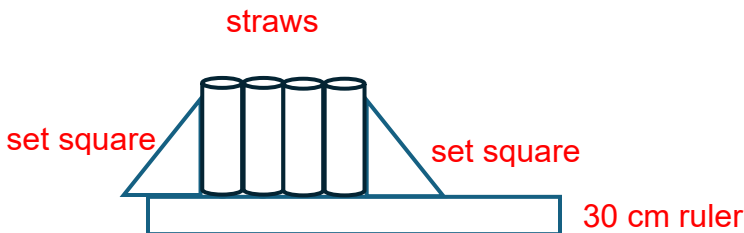
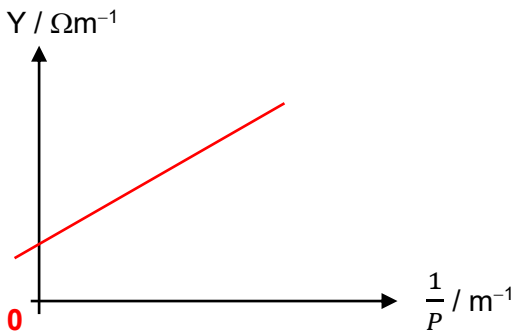


Marking Scheme with Report

1 (a)(i)	l recorded to the nearest 0.1 cm within range $l = (20.8 \text{ cm to } 23.0 \text{ cm})$	1
(a)(ii)	D recorded to the nearest 0.1 cm $D = (2.2 \text{ cm to } 2.6 \text{ cm})$	1
(a)(iii)	$(a)(ii) \div 4$ to the correct s.f. (follow s.f. of 1aii) $d = 2.4 \div 4 = 0.60 \text{ cm}$ (2 s.f. or 3 s.f.)	1
	Common Error: Many corrected to 1 d.p.	
(a)(iv)	correct use of set squares at each end lined up with 30 cm ruler or correct diagram with labels  The diagram illustrates the experimental setup for measuring the diameter of a straw. Four straws are placed side-by-side on a flat surface. Two set squares are positioned at the ends of the straws, with their hypotenuses facing outwards. A 30 cm ruler is placed below the straws, aligned with the set squares. The distance between the two set squares is labeled as 'D'. - Place the four straws side by side between the two set squares. - Align bottom of straws to the 30 cm ruler. - Read off measurement of D by placing eye directly above the ruler scale.	1
	Common Error: Many left out ruler.	
(a)(v)	correct calculation of V_1 from values of L and d V_1 given to correct number of significant figures (2 s.f.) (allow 3.s.f.) (Allow ECF of significant figures from 1aiii) $V_1 = \frac{3.14 d^2 l}{4} = \frac{3.14 (0.60)^2 (21.9)}{4} \approx 6.0 \text{ cm}^3 \text{ (2 s.f.)}$	1 1
(b)(i)	V_T measured to nearest 0.5 cm ³ $V_T = 25.0 \text{ cm}^3$ Acceptable range: (22.0 cm ³ to 28.0 cm ³)	1
	Common Error: Many did not record for 5 transfers.	
(b)(ii)	$(b)(i) \div 5$ (follow sig.fig.) $V_2 = 25.0 \div 5 \approx 5.00 \text{ cm}^3$ (3 s.f.) $V_2 < V_1 + \text{least s.f.}$	1

(c)	[2] Any two from: - air bubbles in the straw in method 2 - internal volume is smaller than external volume - straw became squashed / damaged - small volume of water may remain in the straw - water sticks to the finger and sides of straw - water sticks to the side of the measuring cylinder - some water falls out during transfer in method 2 - straw is not completely filled rejected: space is occupied by finger, volume of air bubble changes	2
		[10]

2 (b)	I measured to the appropriate precision and with correct unit: $I = 0.10 \text{ A}$ Acceptable range: (0.08 A to 0.12 A)	1
	Common Error: Missing unit	
(c)	V measured to the appropriate precision and with correct unit: $V = 1.60 \text{ V}$ Acceptable Range: (1.40 V to 1.80 V)	1
	Common Error: Outside of the range	
(d)(i)	Correct calculation of X, written in 2/3 s.f. <u>AND</u> with correct unit: $X = \frac{V}{I} = \frac{1.60}{0.10} = 16 \Omega$ (2 or 3 s.f.) and unit allow e.c.f. + allow for 1 more s.f.	1
(d)(ii)	Correct calculation of Y, written in 2/3 s.f. <u>AND</u> with correct unit: $P = 0.40 \text{ m}$ $Y = \frac{X}{P} = \frac{16}{0.40} = 40 \Omega/\text{m}$ $= 40 \Omega/\text{m}$ allow for 1 more s.f.	1
(e)	$Y = a \left(\frac{1}{P} \right) + b$ where a and b are constants.	
	A control variable to be kept constant: The e.m.f. of the batteries / number of cells used/ more current	1
	- A detailed description of how you would perform the experiment: - Set up the apparatus as shown in Fig. 2.1. - Close the switch. Record the current I shown on the ammeter. - The distance along the wire between the crocodile clips J and the end of the metre rule is P. Place the jockey on the resistance wire for the distance $P = 0.3 \text{ m}$. Record the potential difference, V shown on the voltmeter in a table. - Calculate the value of Y using the equation $Y = \frac{V}{(I \times P)}$.	

	5. Keeping key variable constant (e.m.f. of battery), repeat steps (3) and (4) for 5 more sets of readings of V for $P < 1.00 \text{ m}$.	1																																			
	A suitable table in which to display your measurements and calculated values (you do not need to enter any data into the table): Record the readings: P, V and calculated value of Y in a table. <table><tr><td></td><td>P / m</td><td>V / V</td><td>$Y / \Omega\text{m}^{-1}$</td><td>$\frac{1}{P} / \text{m}^{-1}$</td></tr><tr><td>1</td><td></td><td></td><td></td><td></td></tr><tr><td>2</td><td></td><td></td><td></td><td></td></tr><tr><td>3</td><td></td><td></td><td></td><td></td></tr><tr><td>4</td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td></td><td></td><td></td><td></td></tr><tr><td>6</td><td></td><td></td><td></td><td></td></tr></table>		P / m	V / V	$Y / \Omega\text{m}^{-1}$	$\frac{1}{P} / \text{m}^{-1}$	1					2					3					4					5					6					1 headings units
	P / m	V / V	$Y / \Omega\text{m}^{-1}$	$\frac{1}{P} / \text{m}^{-1}$																																	
1																																					
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	- A statement of the graph that you would plot to test the relationship: Plot a graph of $Y / \Omega\text{m}^{-1}$ against $\frac{1}{P} / \text{m}^{-1}$. - If the relationship is valid, Y will be linearly related to $\frac{1}{P}$ with a positive gradient. OR Y increases linearly with $1/P$.	1																																			
(e)	A sketch of the graph that you would obtain if the suggested relationship were correct:  Must show zero at the origin. Must show a diagonal straight line to show the relationship.	1																																			
	An explanation of how you would obtain a value of the constants b from your graph: Constant b is the y-intercept of the graph plotted.	1																																			
	Note: See how the above equation was obtained on the last page.	[10]																																			

3(a)(i)	M is measured to <u>2 dp</u> in g. AND between 25.00 g – 35.00 g M = 30.49 g	1
	Common Error: 1 d.p. (Wrong Precision)	
3(a)(ii)	V is measured to <u>1 dp</u> in cm ³ AND between 2.0 – 4.0 cm ³ V = 3.0 cm ³ (There should be no attempt to calculate V using radius or diameter of bob. Lose this mark if so)	1
3(b)	Shows a correct conversion of 10 N/kg to 0.01 N/g or otherwise Hence shows the correct calculation of B in N. [1] Allow 1m if there is no conversion but calculate correctly Allow least sf to be 2 or 3 [calc + s.f.][1] B = 1.0 x 3.0 x 0.010 = 0.030 N	2
3(c)(i)	x and L is measured to <u>1 dp</u> in cm	1
3(c)(ii)	x/L is calculated correctly to <u>least sf</u> , no unit.	1
3(d)	<u>5 readings</u> of data recorded to the correct precision . <i>m (exact), x and L (1 dp)</i>	2
	Correct calculation of x/L, <u>all least sf (based on x and L)</u>	1
	Correct trend, as 1/m increases, x/L <i>increases</i>	1
	Correct heading, with correct units (1/m / g ⁻¹) and (x/L) has no unit	1
3(e)	Graph drawn with x/L as y-axis and 1/m as x-axis, and correctly labelled with units.	1
	Sufficient scale marking every 2 cm and suitable scale - not based on 3, 6, 7, etc. Points occupy at least half of the graph paper in both axes.	1
	All points plotted correctly. (Within half the smallest grid square)	1
	Best fit line is drawn.	1

3(f)	Identified and labelled two coordinates on the graph and use of a triangle that uses more than half the drawn line.	1
	<u>Correct calculation</u> of gradient. The input data should be <u>read to half the smallest square</u> on the grid (correct substitution). Answer to be given in <u>least s.f.</u> and <u>correct unit if given</u>. (No unit is needed for gradient) Gradient = $(0.5000 - 0.1200) / 0.0188 - 0.0044$ = 26 (2 s.f.)	2
3(g)	Make use of calculated gradient, data measured from experiment and data from graph. Compare actual and experimental data with correct conclusion. The suggested relationship is supported. The gradient is 26, which represents $M - \frac{B}{g}$. Using the measured values, $\frac{B}{g} = \frac{0.03}{0.010} = 3.0$ g, so $M - \frac{B}{g} = 30.49 - 3.0 = 27.49$ g, which is close to the gradient of 26, allowing for experimental error. Conclusion based on gradient obtained versus the measured data.	2
	Note: If B is wrong data, no mark is awarded.	
3(h)	A valid suggestion to ensure the accuracy of experiment, with a valid explanation. E.g Suggestion: Use a ruler to measure ensure the height on both ends of the metre rule are equal, Explanation: To ensure the distance measured from mass to pivot is perpendicular. OR Suggestion: C.G. of the metre rule may not be at the 50cm pivot. Use plasticine to shift its C.G. to the pivot point at 50cm marking. Explanation: So that the weight of the metre rule will not contribute to any turning effect.	1
	Rejected: Avoid parallax error by reading at eye level, Mention of wind, Thinner string. A few only mention to ensure it is horizontal without describing how to ensure.	

Setter's Data

m / g	$1/m / g^{-1}$	x / cm	L / cm	x/L
50	0.020	10.6	20.0	0.53
100	0.010	5.3	20.0	0.27
150	0.0067	5.4	30.0	0.18
200	0.0050	5.4	40.0	0.14
250	0.0040	4.9	45.0	0.11

Planning Question:

Relationship Between Length P and Total Resistance X:

For a uniform resistance wire, its resistance is directly proportional to its length.

Let k be the resistance per unit length of the wire.

The resistance of the wire segment of length P is kP. Since the resistor R is in series with this wire segment, the total resistance X (the sum of the resistance of length P and the resistance of R) increases linearly with the length P.

This can be expressed as:

$$X = kP + R$$

Equation Linking X/P and 1/P

To find the relationship between X/P and 1/P, you simply take the equation above and divide all terms by P:

$$X/P = (kP + R) / P$$

$$X/P = k + R/P$$

Rearranging this to match the format of a straight-line graph equation ($y = mx + c$):

$$X/P = R(1/P) + k$$

$$Y = a(1/P) + b$$

- ☐ • y-axis variable: X/P
- ☐ • x-axis variable: 1/P
- ☐ • Gradient (m): R (the resistance of the fixed resistor)
- ☐ • y-intercept (c): k (the resistance per unit length of the wire)