Question 1

You are provided with the following:

- two cells in a cell holder;
- a switch;
- a micrometer screw gauge;
- a nichrome wire mounted on a millimetre scale;
- a voltmeter;
- an ammeter;
- a jockey;
- connecting wires with crocodile clips.

Proceed as follows:

(a) Using the micrometer screw gauge, measure and record the diameter d of the wire.

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d = 0.29 ± 0.02 ½ mm . 2 d.p a must 0.27 ↔ 0.31

d = 2.9 × 10⁻⁴ ½ m • Conversion of students value correctly • Accept std form to whatever no. of d.p (1 mark)

(b) Set up the apparatus as shown in **Figure 1.**

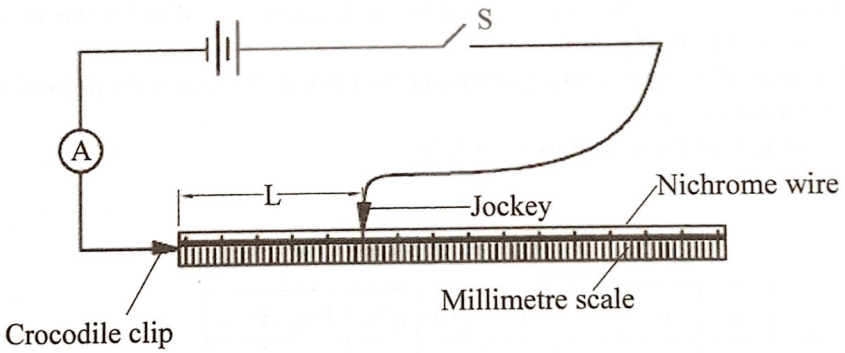

Figure 1

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(c) Using the voltmeter, measure the potential difference E across the battery before closing the switch.

E = 3.1 ± 0.1 ✓1 volts. • 1 d.p a must (1 mark)

(d) Adjust the length L of the wire to 0.1 m (10 cm). Close the switch, read and record the value of the current I in **Table 1**.

(e) Repeat (d) for the other values of L given in **Table 1**. Complete the table. (6 marks)

Table 1

Length L (m)	0.1	0.2	0.3	0.4	0.5	0.6	0.7
Current I (A) ±0.10	0·72	0·53	0·44	0·38	0·33	0·29	0·27
$\frac{1}{I} A^{-1}$	- Correct reciprocals exact or to 4 s.f -- All correctly done award 1 mark						

1 mark @ upto 5 = 5mks

- 2dp a must
- Trend - Decreasing from the 1st correct value

(f) On the grid provided; plot the graph of $\frac{1}{I}$ (y axis) against L. (5 marks)

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Axes ✓1 – 1 mark
- Labelled with Quantity & correct units or correct unit alone ($\frac{1}{A}$ or A^{-1}) ; (M). Accept correct unit stated in the scale or at the title.

Scale ✓1 – 1 mark
- Simple, uniform and accommodative

Plotting – 2 marks
- All points correctly plotted within one small square.
- Award ½ mark for (@) correctly plotted points to a maximum of four.
- ~~Deduct~~ Subtract 1 mark for misplaced point (leading to wrong plotting)

Line – 1 mark
- Should pass through at least 3 correctly plotted points
- Should have a positive slope

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(g) From the graph, determine the:

(i) gradient S; (3 marks)

1 – $\frac{\Delta \frac{1}{I}}{\Delta L}$ ✓1 or Extracting correctly i.e. correct interval and size

- Accept Transfer of error or Ca… corrected power of 10
- No line mk no slope mk.

1 – Accept Correct interval and size (within grid) award mark. It can be deduced from the graph.

1 – Correct evaluation exact or to 4 s.f. award 1 mk. $(A^{-1}M^{-1})$ or $(M^{-1}$ … or $\left(\frac{1}{AM}\right)$

– Deny evaluation mk if the unit is wrong; Deny ½ mk for missing unit.

(ii) intercept C on the $\frac{1}{I}$ axis. (1 mark)

- Candidates value of C taking into account Candidate Error transfer either positive or negative with correct units award 1 mark
- ~~Deny ½ mark for missing unit~~
- C-value should be within the grid.
- Wrong units correct evaluation – ½ mark

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(h) Given that:

(i) $\frac{4K_1}{\pi d^2 E} = S$ determine the value of K_1. (2 marks)

✓ Correct substitution S, d (any two) and E – Award 1mk

✓ Correct evaluation exact or to 4 s.f. – Award 1mk

✓ Ignore units

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(ii) $\frac{K_2}{E} = C$ determine the value of K_2. (1 mark)

✓ Correct substitution of C and E award ½mk

✓ Correct evaluation exact or 4 s.f. award ½ mk.

✓ Ignore unit.

Question 2

You are provided with the following:

- a metre rule;
- a biconvex lens;
- a source of light (bulb in a bulb holder, cells in a cell holder and a switch);
- a stand boss and clamp;
- a lens holder;
- a screen;
- a half metre rule;
- three pieces of plastic pipes A, B and C;
- a vernier callipers (to be shared);
- a stopwatch;
- some plasticine.

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Proceed as follows

PART A

(a) Clamp the bulb holder onto the stand. Arrange the bulb, the lens and the screen along the metre rule as shown in **Figure 2**.

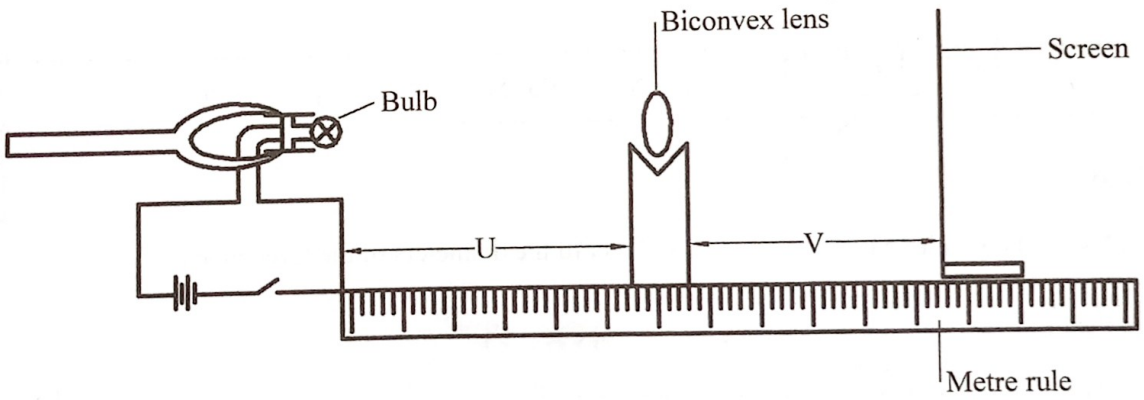

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Figure 2

(b) Adjust the distance of the bulb from the lens to U = 25 cm. Put on the switch and adjust the position of the screen from the lens so that a sharp image of the bulb is observed. Record the distance V between the screen and the lens in **Table 2**.

(c) Repeat part (b) for the other values of U shown in **Table 2**. Complete the table. 5 (~~7~~ marks)

Table 2

U cm	25	30	35
V cm 1d.p	45.0	35.0	30.0
$M = \frac{V}{U}$	- Each value correctly evaluated Exact or to 4.S.f - All correct award 1 mk.		
$F = \frac{V}{M+1}$	- Correct evaluation exact or to 4 S.f - All correct award 1 mk.		

±10 cm @ 1mk ; values with decreasing trend -

(d) Determine the average value of F. (2 marks)

- Statement of principle of averaging students value award 1 mk.
- Correct evaluation exact or to 4 S.f - award 1 mk.
- Ignore units.

$\frac{F_1 + F_2 + F_3}{3}$ ⇒ Principle of averaging shown.

PART B

(e) Using the vernier callipers measure and record the diameters of the three pipes.

d_A, d_B and d_C 2 d.p

d_A = 3.00 - 3.70 ✓1 cm ..... m Correct conversion ½ (1 mark)

d_B = 3.60 - 4.90 2d.p ✓1 cm ..... m Correct conversion ½ (1 mark)

d_C = 5.10 - 5.80 2d.p ✓1 cm ..... m Correct conversion ½ (1 mark)

(f) Measure and record the thickness X of the half metre rule.

X = 0.50 - 0.65 2dp ✓1 cm ..... m Correct conversion ½ (1 mark)

(g) Place the pipe marked A on the bench and use the plasticine to stop it from rolling. **(see Figure 3 (a))**.

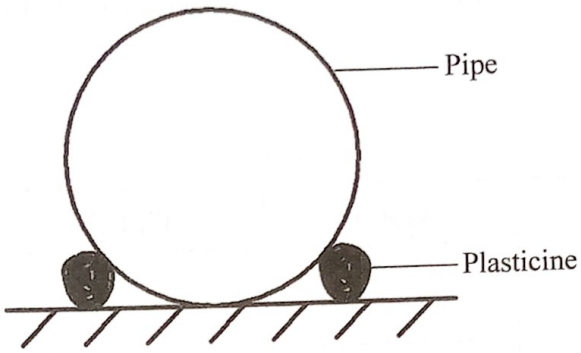

Figure 3 (a)

(h) Place the half metre rule onto the pipe such that it balances horizontally. Ensure that the half metre rule is perpendicular to the axis of the pipe. **(see Figure 3 (b))**.

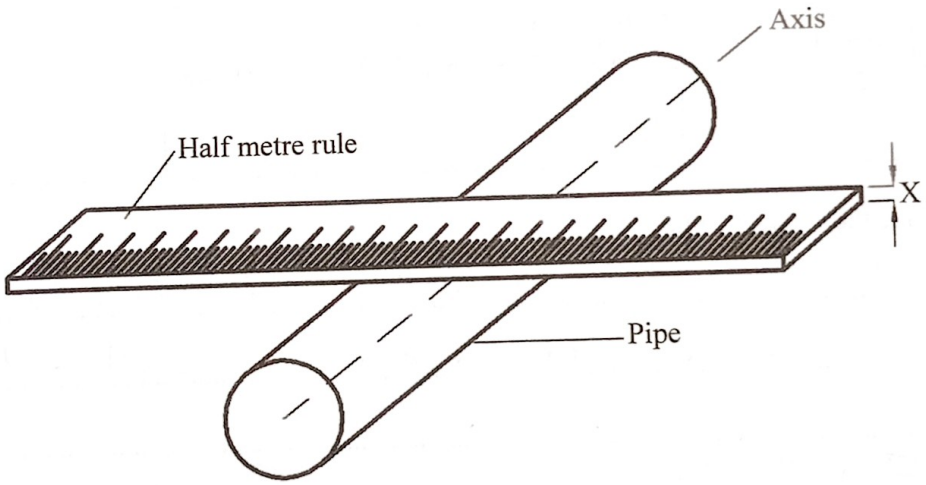

Figure 3 (b)

$V = \frac{3\pi d^2 L}{4}$

(i) Push one end of the balanced half metre rule slightly downwards and release it so that it oscillates up and down. Measure and record in **Table 3** the time for five complete oscillations.

(j) Repeat the procedure in (g), (h) and (i) for the other pipes B and C. Complete **Table 3.**

(5 marks)

Table 3

	Pipe A	Pipe B	Pipe C
Diameter d (m)			
Time for five oscillations	12.60	10.60	9.80
Periodic time T (s)	✓ Correct evaluation exact or to 4 s.f	all correct 1 mark	
$Z = T\sqrt{\frac{3(d-x)}{2}}$	✓ Each value correctly evaluated $\frac{1}{2}$ mark to a max of 1 mark ✓ 4 S.f or exact ✓ Value of X must be in Metres.		

± 1 to 2dp @ 1 mark

(k) Determine the average value of Z.

(2 marks)

- Statement of principle of averaging of Students value — 1mark
- Correct evaluation exact or 4 s.f (ignore unit) — 1 mark

Eg $\frac{Z_1 + Z_2 + Z_3}{3}$ (principle of averaging shown)

- If work is cancelled and replaced, mark the replaced one
- If work is cancelled and not replaced, mark the cancelled one.

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