

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.

~~$d = (2.8 - 3.0) \times 10^{-1}$ allowed~~
 $d = (2.7 - 3.1) \times 10^{-1}$ allowed

Proceed as follows:

(a) Using the micrometer screw gauge, measure and record the diameter d of the wire. $\frac{1}{2}$

$d = \dots\dots\dots$ mm

$(0.28 - 0.30) \sqrt{2} (0.27 - 0.31 \text{ mm}) \sqrt{2}$
 $0.29 \pm 0.02 \text{ mm}$ 2 d.p a must
 std form allowed

$d = \dots\dots\dots$ m

$\sqrt{2}$ student's own conversion? accept calculation ✓
 std form allowed ✓
 screen appearance (1 mark) ✓

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

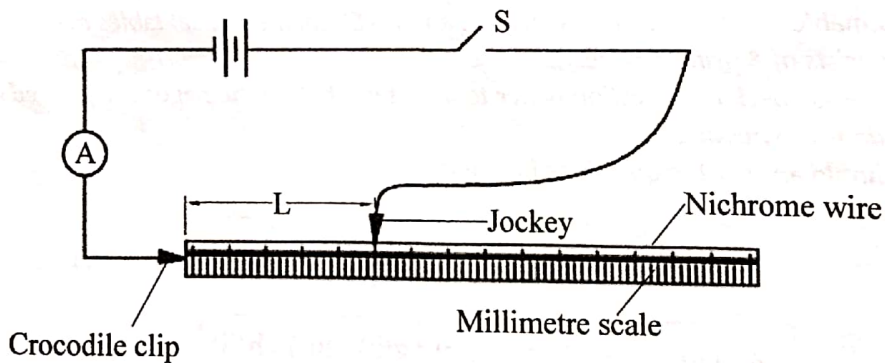


Figure 1

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

$E = \dots\dots\dots$ volts.

$(3.0 - 3.2)$ volts. (3.0 ± 0.1) ✓
 1 d.p a must
 whole number penalised.
 penalise 3V (1 mark)

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(g) From the graph, determine the:

(3 marks)

(i) gradient S;

NO LINE NO SLOPE

$\frac{\Delta y}{\Delta x}$ marked independently (subtraction)

Correct evaluation exact or 4 sf (3 d.p in std form)

Correct units $A^{-1} m^{-1}$
 missing unit - penalise 1/2 mark
 wrong unit - penalise fully 2 for evaluation

(1 mark)

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

allow transfer of candidate's corrected value.
 award even if intercept is -ve (-ve slope)

must have correct unit $A^{-1} m^{-1}$

penalise 1/2 mark without unit
 deny whole 1 mark for wrong unit
 Line cut y -axis x - must start from zero

(h) Given that:

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

(2 marks)

Use $\pi = \frac{22}{7}$ or 3.142

correct substitution of S , d and E ✓ d mm or m

Correct evaluation (exact or 4sf) ✓ deny 3.14
 Accept whichever d mm or m. ignore the units

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

(1 mark)

substitution
 Correct Δ of E and C ✓ 1/2 mark.

Correct evaluation (exact or 4sf) ✓ 2 mark
 ignore unit

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PART

(a)

- (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. (7 marks)

Table 2

U cm	25	30	35
V cm	45.0	35.0	30.0
$M = \frac{V}{U}$			
$F = \frac{V}{M+1}$			

decreasing trend.
1 dp a must.
Correct evaluation to exact or 4 sf (3 dp in std form).
Correct evaluation to 4f or exact (3 dp in std form). ✓

- (d) Determine the average value of F .

05 marks (2 marks)

principle of averaging $\frac{f_1 + f_2 + f_3}{3}$ ✓ 1 mark.
Correct evaluation to 4 sf or exact ✓ 1 mark.
Ignore units

PART B

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

d_A, d_B and d_C

$d_A = \dots \text{cm} \dots \text{m}$

$d_B = \dots \text{cm} \dots \text{m}$

$d_C = \dots \text{cm} \dots \text{m}$

$d_A = 3.00 - 3.70$ ✓ 2 dp a must
 $d_B = 3.60 - 4.90$ ✓ 2 dp a must
 $d_C = 5.10 - 5.80$ ✓ 2 correct evaluation of candidate's value. Ignore the accuracy of instrument. accept calculator's value.
(1 mark)
(1 mark)
(1 mark)

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

$X = 0.50 - 0.65 \text{ cm} \dots \text{m}$

Correct conversion of student's value. ✓ (1 mark)

$d_A = 3.00 - 3.70 \text{ cm}$ ✓
 $d_B = 3.60 - 4.90 \text{ cm}$ ✓
 $d_C = 5.10 - 5.80 \text{ cm}$ ✓ } 2 dp a must

- (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)

unit for time not emphasised.

Table 3

	Pipe A	Pipe B	Pipe C
Diameter d (m)			
Time for five oscillations ± 1.00	12.60 ✓	10.60 ✓	9.80 ✓ 2 dp
Periodic time T (s)	correct evaluation (exact or 4 sf or 3d.p in std form. all correct. ✓)		
$Z = T \sqrt{\frac{3(d-x)}{2}}$	d is in metres x must be in metres Correct evaluation of Z (exact or 4 sf any two correct values ✓)		

- (k) Determine the average value of Z. (2 marks)

11.60 - 13.60 | 9.60 - 11.60 | 8.80 - 10.80 05 marks

$\frac{Z_1 + Z_2 + Z_3}{3}$ ✓ max. (showing a method)

Correct evaluation (exact or 4 sf (3d.p in std))
ignore units.

11.60 - 13.60 | 9.60 - 11.60 | 8.80 - 10.80

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a, c, e 8 1
f 2

$\frac{1}{f} - \frac{1}{v} = \frac{1}{v}$

11.9135 ✓

