To Find Resistance Of a Given Wire Using Metre Bridge & Hence Determine The Resistivity (Specific Resistance) Of Its Material.

Aim

To find resistance of a given wire using Metre Bridge and hence determine the resistivity (specific resistance) of its material.

Apparatus

A metre bridge (slide wire bridge), a Leclanche cell (Battery eliminator), a galvanometer, a resistance box, a jockey, a one way key, a resistance wire, a screw gauge, a metre scale, a set square, connecting wires and a piece of sand paper.

Theory

(i) The unknown resistance X is given by

$$X = \frac{(100 - l)}{l} \cdot R$$

where, R is known resistance placed in the left gap and unknown resistance X in the right gap of metre bridge. I cm is the length of metre bridge wire from zero end upto balance point.

(ii) Specific resistance (p) of the material of the given wire is given by

$$\rho = \frac{X\pi D^2}{4L}$$

where, L is the length and D is the diameter of the given wire.

Circuit diagram

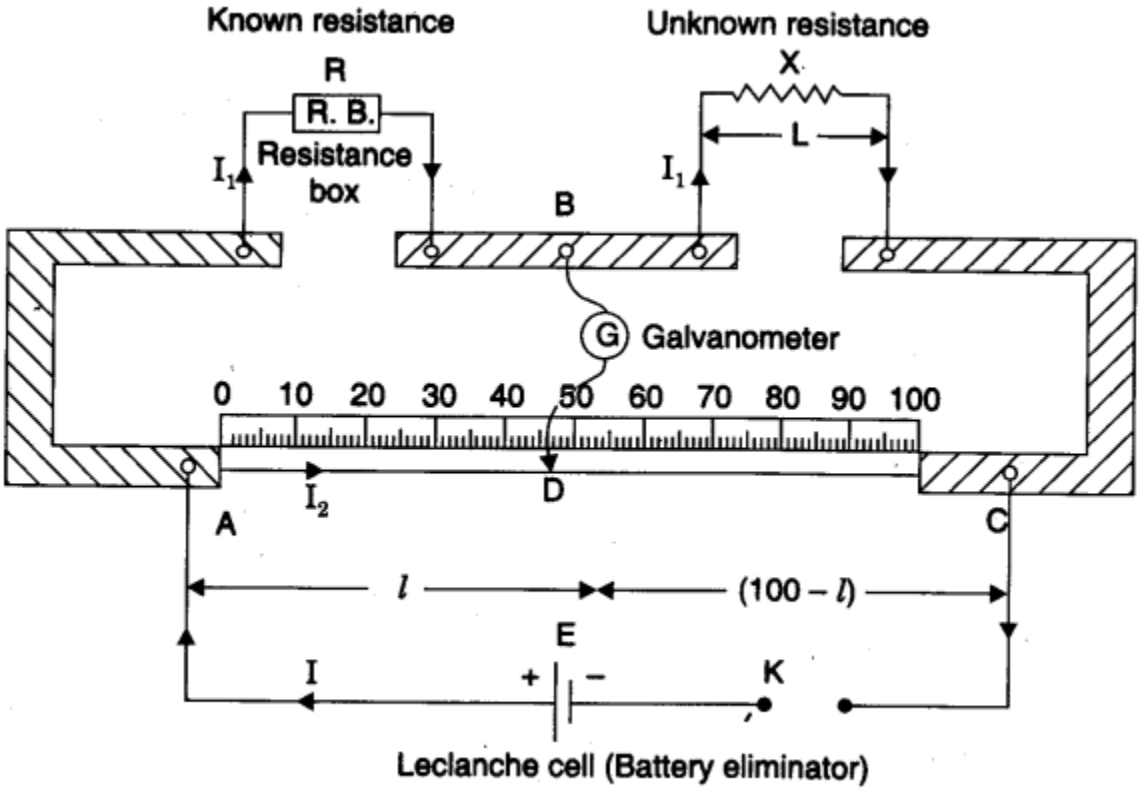


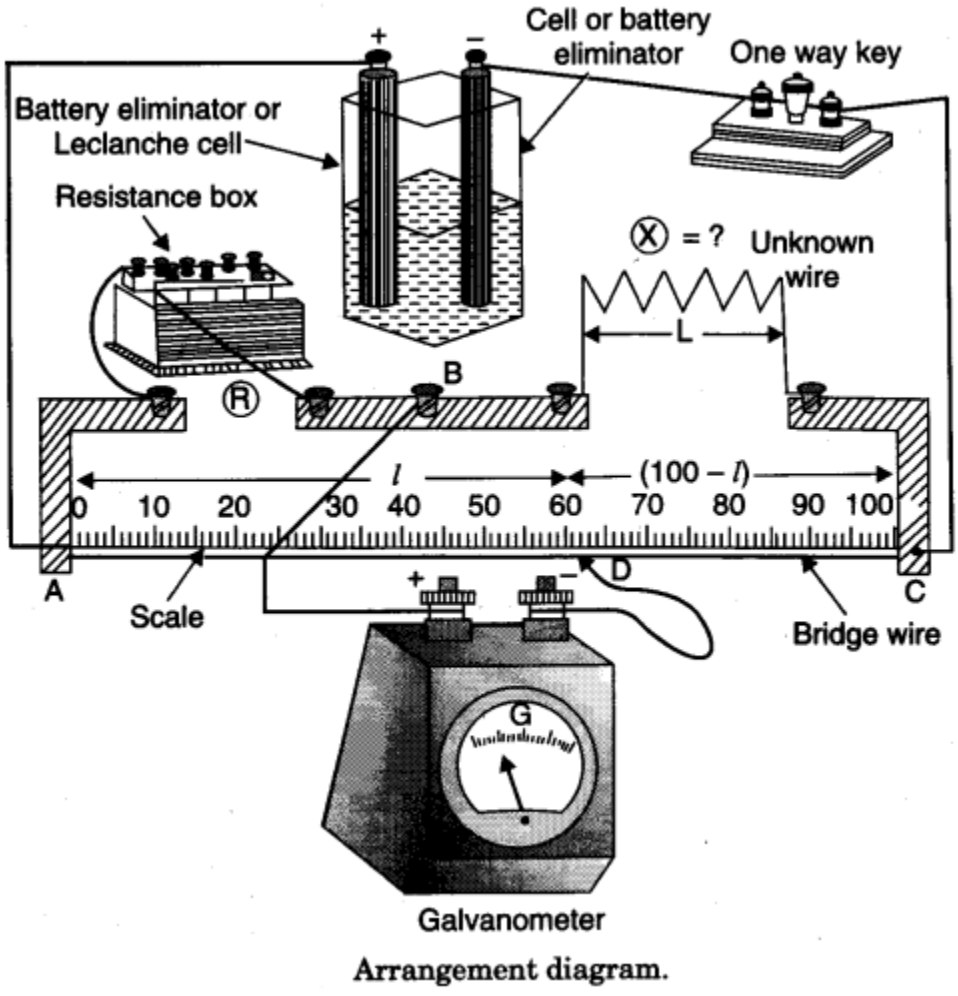
Fig. Circuit diagram—Metre bridge.

Procedure

For Resistance

1. Arrange the apparatus as shown in arrangement diagram.
2. Connect the resistance wire whose resistance is to be determined in the right gap between C and B. Take care that no part of the wire forms a loop:
3. Connect resistance box of low range in the left hand gap between A and B.
4. Make all the other connections as shown in the circuit diagram.
5. Take out some resistance (say 2 ohm) from the resistance box, plug the key K.
6. Touch the jockey gently first at left end and then at right end of the bridge wire.
7. Note the deflections in the galvanometer. If the galvanometer shows deflections in opposite directions, the connections are correct. If the deflection is one side only, then there is some fault in the circuit. Check or take help of your teacher and rectify the fault.
8. Move (slide) the jockey gently along the wire from left to right till galvanometer gives zero deflection. The point where the jockey is touching the wire is null point D.

9. Choose an appropriate value of 12 from the resistance box such that there is no deflection in the galvanometer when the jockey is nearly in the middle of the wire (i.e. Between 45 cm to 55 cm).
10. Note position of point D (with the help of a set square) to know length AD = l.
11. Take at least four sets of observations in the same way by changing the value of 12 in steps.
12. Record your observations.



Arrangement diagram.

For Specific Resistance

13. Cut the resistance wire at the points where it leaves the terminals, stretch it and find its length by using a metre scale.
14. Measure the diameter of the wire at least at four places, in two mutually perpendicular directions at each place with the help of screw gauge.
15. Record your observations as given in tables.

Observations

1.Length of given wire L = cm.

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2. Table for unknown resistance (X)

Serial No. of Obs.	Load on hanger (W) = Applied force (F) (g wt)	Reading of position of pointer tip			Extension l (cm)
		Loading x (cm)	Unloading y (cm)	Mean $z = \frac{x+y}{2}$ (cm)	
1.	0				
2.	50				
3.	100				
4.	150				
5.	200				
6.	250				
7.	300				

3. Least count of the screw gauge

Pitch of screw gauge = ... mm

Total no. of divisions on the circular scale = ...

$$\therefore \quad \text{L.C. of the given screw gauge} = \frac{\text{Pitch}}{\text{No. of divisions on the circular scale}}$$

$$= \text{..... mm}$$

$$\text{Zero error } e = \text{..... mm}$$

$$\text{Zero correction } c = -e = \text{..... mm}$$

4. Table for diameter (D) of the wire

Table 1. Diameter of experimental wire

Serial No. of Obs.	Linear Scale Reading N (cm)	Circular Scale Reading		Total Reading $N + n \times (L.C.)$ d (cm)
		No. of division on reference line (n)	Value $n \times (L.C.)$ (cm)	
1. ⊖ ⊕				$d_1 =$
				$d_2 =$
2. ⊖ ⊕				$d_3 =$
				$d_4 =$
3. ⊖ ⊕				$d_5 =$
				$d_6 =$
4. ⊖ ⊕				$d_7 =$
				$d_8 =$
5. ⊖ ⊕				$d_9 =$
				$d_{10} =$

Calculations

1. Calculation for X

1. From position of D, find l cm and write in column 3 of Table 1.
2. Find length $(100 - l)$ cm and write in column 4.
3. Calculate X and write in column 5.

$$\text{Mean } X = \frac{X_1 + X_2 + X_3 + X_4}{4} = \ldots\ldots \text{ ohm}$$

2. Calculation for D

$$\text{Mean corrected diameter} = \frac{D_1(a) + D_2(b) + \ldots\ldots + D_4(a) + D_4(b)}{8}$$

$$= \ldots\ldots \text{ mm} = \ldots\ldots \text{ cm}$$

3. Calculation for Specific Resistance

Specific resistance of the material of the given wire,

$$\rho = X \cdot \frac{\pi D^2}{4L}$$

$$= \ldots\ldots \text{ ohm-cm}$$

$$= \ldots\ldots \text{ ohm-m}$$

Standard value of the specific resistance of the material of the given wire (if given),

$$\rho_0 = \ldots\ldots \text{ ohm-m}$$

$$\text{Percentage error} = \frac{\rho - \rho_0}{\rho_0} \times 100$$

$$= \ldots\ldots \%.$$

Result

1. The value of unknown resistance X =……
2. The specific resistance of the material of the given wire =……
3. Percentage error =…….

Precautions

1. The connections should be neat, clean and tight.
2. All the plugs in the resistance box should be tight.
3. Move the jockey gently over the bridge wire and do not rub it.
4. The plug in key K should be inserted only when the observations are to be taken.
5. Null point should be brought between 45 cm and 55 cm.
6. Set square should be used to note null point to avoid error of parallax.
7. At one place, diameter of wire should be measured in two mutually perpendicular directions.

8. The wire should not make a loop.

Sources of error

1. The instrument screws may be loose.
2. The plugs may not be clean.
3. The wire may not have uniform thickness.
4. The screw gauge may have faults like back lash error and wrong pitch.