To Study The Variation In Potential Drop With Length Of a Wire For a Steady Current

Aim

To study the variation in potential drop with length of a wire for a steady current.

Apparatus and material

Apparatus. Potentiometer:
Material: A fully charged 4.5 V battery or battery eliminator, a low resistance rheostat, a voltmeter of range (0-3.0 V), an ammeter (0-3) A, a one way key, a jockey, a set square, connecting wires and a piece of sand paper.

Theory

For a potentiometer with wire of uniform material density and thickness (cross-sectional area) carrying a steady current, potential drop is proportional to the length of the wire.

$$i.e., \qquad V \propto l$$

$$\Rightarrow \qquad V = Kl$$

$$K = \frac{V}{l} = \text{constant}$$

where K is the drop of potential per unit length. It is called the potential gradient.

Diagram

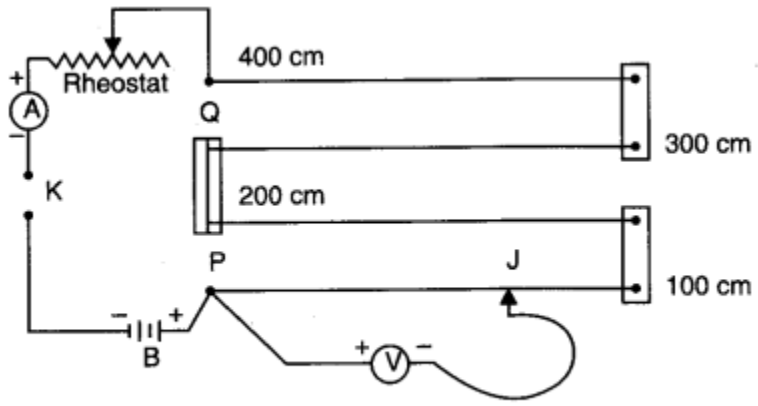


Fig. Studying variation in potential drop with length of a wire.

Procedure

1. Draw a circuit diagram showing the scheme of connections as in figure.
2. Remove the insulation from the ends of the connecting copper wires with a sand paper.
3. Connect the positive pole of the battery (eliminator) (a battery of constant e.m.f.) to the zero end (P) of the potentiometer and the negative pole through a one-way key, an ammeter and a low resistance rheostat to the other end (Q) of the potentiometer.
4. Connect the positive terminal of the voltmeter to the end P of the potentiometer and the negative terminal to the jockey.
5. Touch the end of the jockey to the end Q of the potentiometer.
6. Close the key and set the rheostat such that the voltmeter gives full scale deflection (3 V).
7. Touch the jockey at end P at 0 (zero) cm. The voltmeter will give zero deflection.
8. Touch the jockey at marks separated by 50 cm length of wire. Note the voltmeter reading in each case.
9. Record your observations in tabular form as given ahead.

Observations and Calculations

Range of voltmeter = 3 V

Least count of voltmeter = 0.05 V

Zero correction of voltmeter = ...

Range of ammeter = 0.3 A

L.C. of ammeter = 0.05 A

Steady current shown by ammeter = ...

Table for length and potential drop

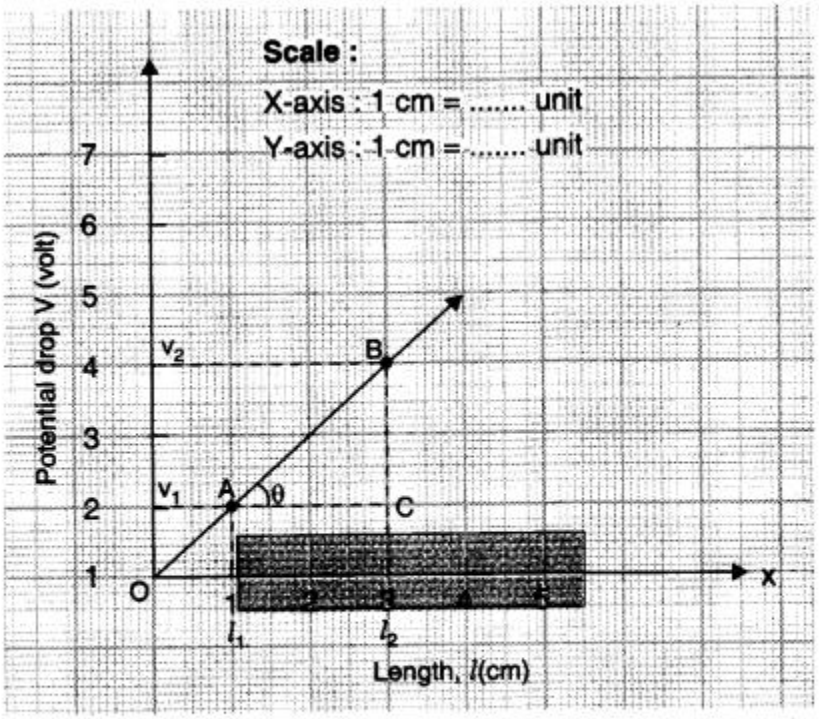
Serial No. of Obs.	*Length of potentiometer wire l (cm)*	*Voltmeter reading V (V)*	*Ratio* $K = \frac{V}{l}$ *(V cm^{-1})*
(1)	*(2)*	*(3)*	*(4)*
1.	0	0	—
2.	50	.....	.....
3.	100	.....	.....
4.	150	.....	.....
5.	200	.....	.....
6.	250	.....	.....
7.	300	.....	.....
8.	350	.....	.....
9.	400	.....	.....

Calculation from graph

Plot a graph choosing a suitable scale, for the values of potential drop V along y-axis and length l along x-axis as shown in figure.

From graph, $$\tan\theta = \frac{BC}{AC} = \frac{V_2 - V_1}{l_2 - l_1} = \frac{V}{l} \quad \ldots(1)$$

But $$K = \frac{V}{l} \quad \ldots(2)$$



From equation (1) and (2)

$$\tan\theta = K$$

The slope of straight line OB gives the value of potential gradient.

Result

(*i*) The graph between V and l is a straight line. Therefore, the potential drop along the length of wire is directly proportional to its length

$$v \propto l$$

$$v = kl$$

(*ii*) The potential drop per unit length of wire is k = ... $V\ cm^{-1}$.