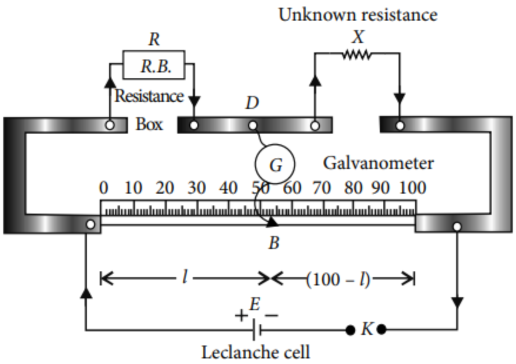
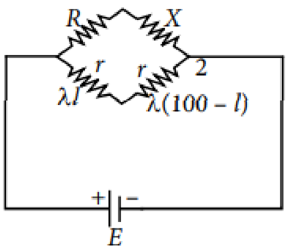
Experiment - 10 : To find resistivity of the material of a given wire using metre-bridge.

Theory

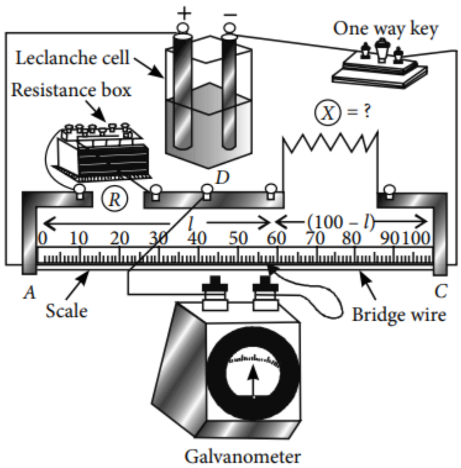
A metre bridge is a practical form of the wheatstone bridge. The circuit is connected as follows with the unknown resistance as one of the resistances



The resistance R, the unknown resistance X, the wire of length l and the wire of length $(100 - l)$ act as the four arms of the wheatstone bridge.



If we take λ as the resistance per unit length, then λl and $\lambda(100 - l)$ will be the resistances of the wires, l and $(100 - l)$ respectively.



According to wheatstone bridge principle, at the null point.

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

As resistivity $\rho = \frac{R \cdot A}{l}$ where A is the cross-section area of the resistance X and l is its length.

If D is the diameter of the wire X, then $A = \frac{\pi D^2}{4}$

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

D is measured using a screw guage and thus specific resistance of X or its resistivity is determined.

MCQs Corner

Experiment – 10

43. In a meter bridge experiment, the corresponding observation table are shown in figure.

S. No.	R (Ω)	l (cm)
1.	1000	60
2.	100	13
3.	10	1.5
4.	1	1.0

Which of the readings is inconsistent ?

(a) 99 (b) 109 (c) 70 (d) 98

44. In a simple metre-bridge circuit, the gaps are bridged by coils P and Q having the smaller resistance. A balance is obtained when the jockey key makes contact at a point of the bridge wire 40 cm from the P end. On shunting the coil Q with a resistance of 50 Ω, the balance point is moved through 10 cm. The resistance P and Q are:

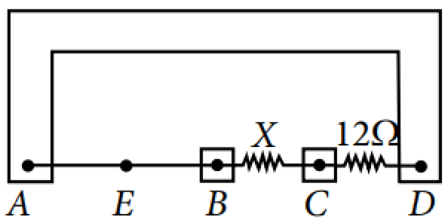
(a) $\frac{25}{3}\,\Omega$, $\frac{25}{2}\,\Omega$ respectively

(b) $\frac{50}{3}\,\Omega$, $\frac{50}{2}\,\Omega$ respectively

(c) $\frac{75}{3}\,\Omega$, $\frac{75}{2}\,\Omega$ respectively

(d) $\frac{100}{3}\,\Omega$, $\frac{100}{2}\,\Omega$ respectively

45. A thin uniform wire AB of length 1 m, an unknown resistance X and a resistance of 12 Ω are connected by thick conducting strips as shown in figure. A battery and a galvanometer (with a sliding jockey connected to it) are also available. Connections are to be made to measure the unknown resistance X using the principle of wheatstone bridge. The appropriate connections are: (E is the balance point for Wheatstone bridge)



(a) battery across EB and galvanometer across BC.

(b) battery across BC and galvanometer across CD

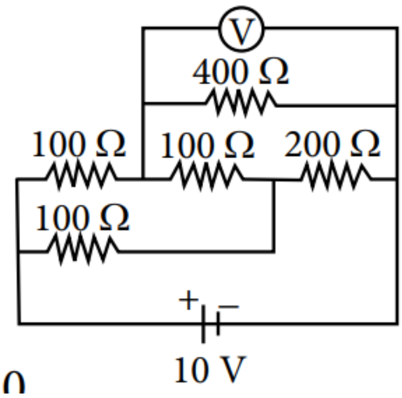
(c) battery across EC and galvanometer across BD

(d) battery across BD and galvanometer across EC.

46. In the above question, after appropriate connections are made, it is found that no deflection takes place in the galvanometer when the sliding jockey touches the wire at a distance of 60 cm from A. The value of the resistance X is

(a) 4 Ω (b) 8 Ω (c) 16 Ω (d) 18 Ω

47. For the electrical circuit shown in the figure, the potential difference across the resistor of 400 Ω as will be measured by the voltmeter V of resistance 400 Ω is



(a) 5V (b) $\frac{10}{3}$ V

(c) 4V (d) $\frac{20}{3}$ V

Answer Key

43. (a) 44. (b) 45. (d) 46. (b) 47. (d)

Hints & Explanation

43. (a) : $\because \frac{R}{X} = \frac{l}{(100-l)}$. So, $X = \frac{R(100-l)}{l}$

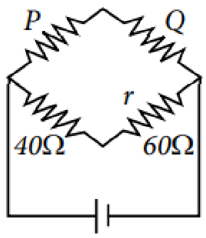
So, $X_1 = \frac{1000\times(100-60)}{60} = \frac{1000\times 40}{60} = 666.66\,\Omega$

$X_2 = \frac{100\times(100-13)}{13} = \frac{100\times 87}{13} = 669.23\,\Omega$

$X_3 = \frac{10\times(100-1.5)}{1.5} = \frac{10\times 98.5}{1.5} = 656.66\,\Omega$

$X_4 = \frac{1\times(100-1)}{1} = 99\,\Omega$

44. (b) :



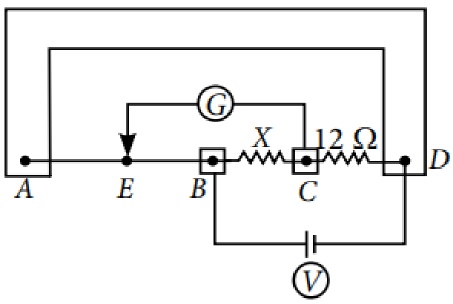
Case 1: $\frac{P}{40} = \frac{Q}{60}$ ...(i)

On shunting Q with 50 Ω, the resistance of the arm containing Q comes down, so length also must shorten to keep the ratio same.

$\Rightarrow \frac{P}{(40+10)} = \frac{\left(\frac{50Q}{50+Q}\right)}{(60-10)} \Rightarrow P = \frac{50Q}{50+Q}$ ...(ii)

Solving (i) and (ii) we get, $P = \frac{50}{3}\,\Omega$ and $Q = \frac{50}{2}\,\Omega$

45. (d) : The appropriate connections for wheatstone bridge are as shown below:

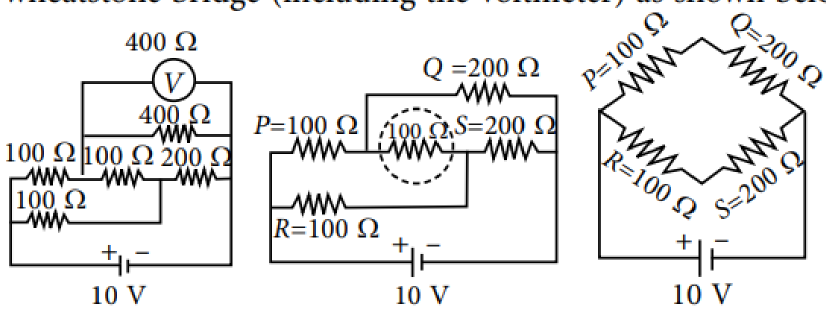


46. **(b) :** No deflection in the galvanometer means wheatstone bridge is balanced. So, $\frac{X}{12} = \frac{R_{BJ}}{R_{AJ}}$

$\frac{X}{12} = \frac{40}{60}$ (As resistance is proportional to the length of the wires)

$\Rightarrow \quad X = \frac{12 \times 4}{6} = 8\ \Omega.$

47. **(d) :** The given circuit actually forms a balanced wheatstone bridge (including the voltmeter) as shown below.



$\Rightarrow$ Voltmeter measures voltage across Q as $\frac{200}{300}(10\text{ V}) = \frac{20}{3}$