EXPERIMENT – 6

P.O. Box

Aim of the experiment: To determine the resistance of a given resistor using P.O. Box (Wheatstone bridge)

Equipment, apparatus, devices required: P.O. Box, DC power supply, rheostat (or a current limiting resistor), galvanometer, experimental resistor

Principle: Wheatstone bridge is a network involving four arms in the form of a quadrilateral each consisting of resistances.
A Wheatstone bridge is balanced when its four arms having resistances P, Q, R and S are in the ratio

$$\frac{P}{Q} = \frac{R}{S}$$

Under this condition the potential difference between points C and D is zero and no current flows through the galvanometer.
If the resistances in the three arms are known, the value of resistance in the fourth arm can be determined.

$$S = \left(\frac{Q}{P}\right) R$$

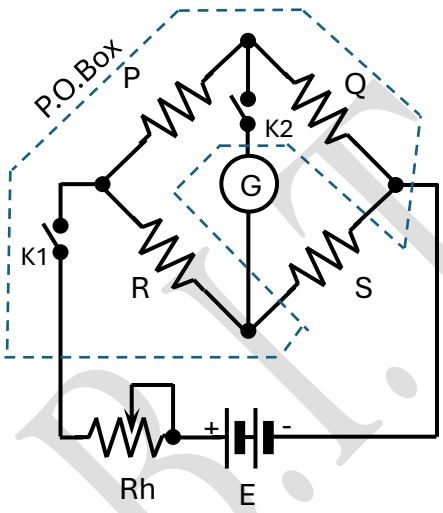

Fig-1. Wheatstone bridge circuit for the determination of value of a resistance.

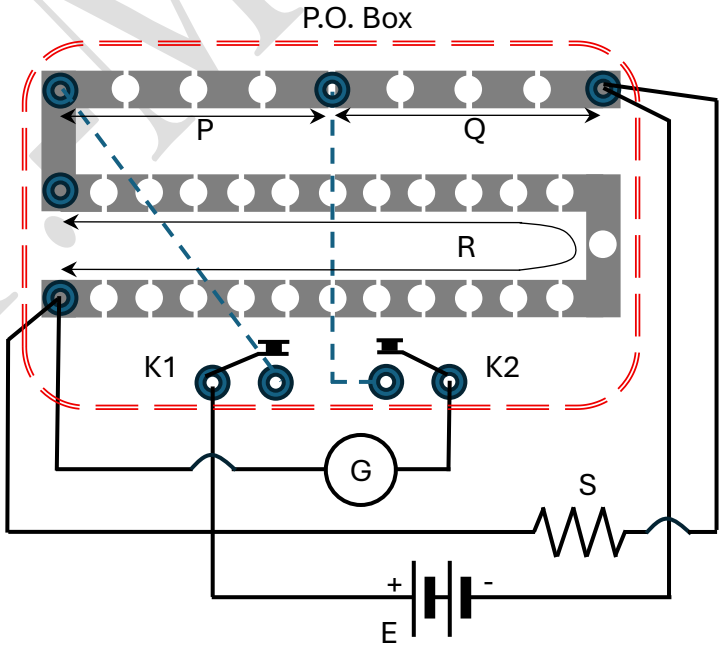

Fig-2. Actual wiring diagram of a Wheatstone bridge using a P. O. Box and its peripheral components.

Procedure and precautions:

1. Identify the P, Q and R arms of the Wheatstone bridge on the P.O. Box.
2. Wire the circuit as per the diagram. You may avoid the use of a dc power supply along with a rheostat and use a Leclanché cell instead, as the current requirement of the circuit for its operation is nominal.
3. Ensure that all the plugs of the PO box are tightly inserted in place and they must be clean as well. This is crucial for the success of the experiment. Even a thin layer of oxide that usually form on metal surfaces, might pose sufficient resistance that you cannot reckon.
4. Pluck out 10Ω key from each arm P and Q, press the two keys K1 and K2 and check for the galvanometer deflection. It may deflect in any direction. Note that the resistance in R arm is still '0' (zero). If the galvanometer deflects towards the right — just remember!
5. Now pluck out the key marked '∞' from the R arm and again check for the deflection. It must deflect towards the other direction. If it doesn't check for a possible fault in the circuit wiring or a loosely inserted key.
6. It however, the galvanometer deflects properly in both the directions upon plucking out 0 and ∞ then proceed to record your observations and inferences.
7. Once you zero-in to a particular value, repeat the process for P=100Ω and Q=10Ω. Note that this time you have to pluck nearly 10 times the resistance value from the R arm than the that for P:Q = 100Ω:10Ω.
8. Subsequently, you may choose a still higher ratio i.e., P:Q = 1000Ω:10Ω. This will enhance the precision of the result to two decimal places.

Observations:

Table-1: Record of trials for estimating the value of a given resistor for
Determination of Unknown Resistance using Post Office Box

Trial No.	P (Ω)	Q (Ω)	R (Ω)	Galvanometer deflection	Inference
1.	10	10	0	Left	$0 < S$
2.			∞	Right	$S < \infty$
3.			5000	Right	$S < 5000\Omega$
4.			2000	Right	$S < 2000\Omega$
5.			1000	Right	$S < 1000\Omega$
6.			500	Right	$S < 500\Omega$
7.			200	Right	$S < 200\Omega$
8.			100	Right	$S < 100\Omega$
9.			50	Left	$S > 50\Omega$
10.			70	Right	$S < 70\Omega$
11.			60	Slight right	$S < 60\Omega$
12.			56	Almost no deflection	$S \approx 56\Omega$
13.	100	10	560	Right	$S < 560$
14.			550	Left	$S > 550$
15.			553	Slight Left	$S > 553$
16.			556	Almost no deflection	$S \approx 556$ i.e., 55.6Ω
17.	1000	10	5560		
18.			5570		

19.			5566		
20.			5562	Almost no deflection	S ≈ 5562 i.e., 55.62Ω

Calculations:

When placed in the fourth arm of the Wheatstone bridge, the value of the resistance to be determined, is,

$$S = \left(\frac{Q}{P}\right) R$$

If the true value of the resistance is already known, then the accuracy of our experiment can be determined using

$$\% \, error = \frac{|S_{true} - S_{estimated}|}{S_{true}} \times 100\%$$

Results and Discussion:

The resistance S = _____, that has been determined with fair degree of accuracy and precision in terms of resistances in the other three arms of the Wheatstone bridge.