

## OBJECTIVE

*To determine the internal resistance of a given primary cell using potentiometer.*

## APPARATUS

A potentiometer, a battery (or battery eliminator), two one-way keys, a rheostat of low resistance, a galvanometer, a high resistance box, a fractional resistance box, an ammeter, a voltmeter, a cell (say Leclanche cell), a jockey, a set square, connecting wires and a piece of sand paper.

## CIRCUIT DIAGRAM

Refer to Fig. 4.03 given on next page.

## THEORY (*Formula used*)

The internal resistance of a cell is given by

$$r = \left( \frac{l_1 - l_2}{l_2} \right) \cdot R$$

where  $l_1$  and  $l_2$  are the balancing lengths without shunt and with shunt, respectively, and  $R$  is the shunt resistance in parallel with the given cell.

## MEASUREMENT OF ELECTROMOTIVE FORCE AND POTENTIAL DIFFERENCE

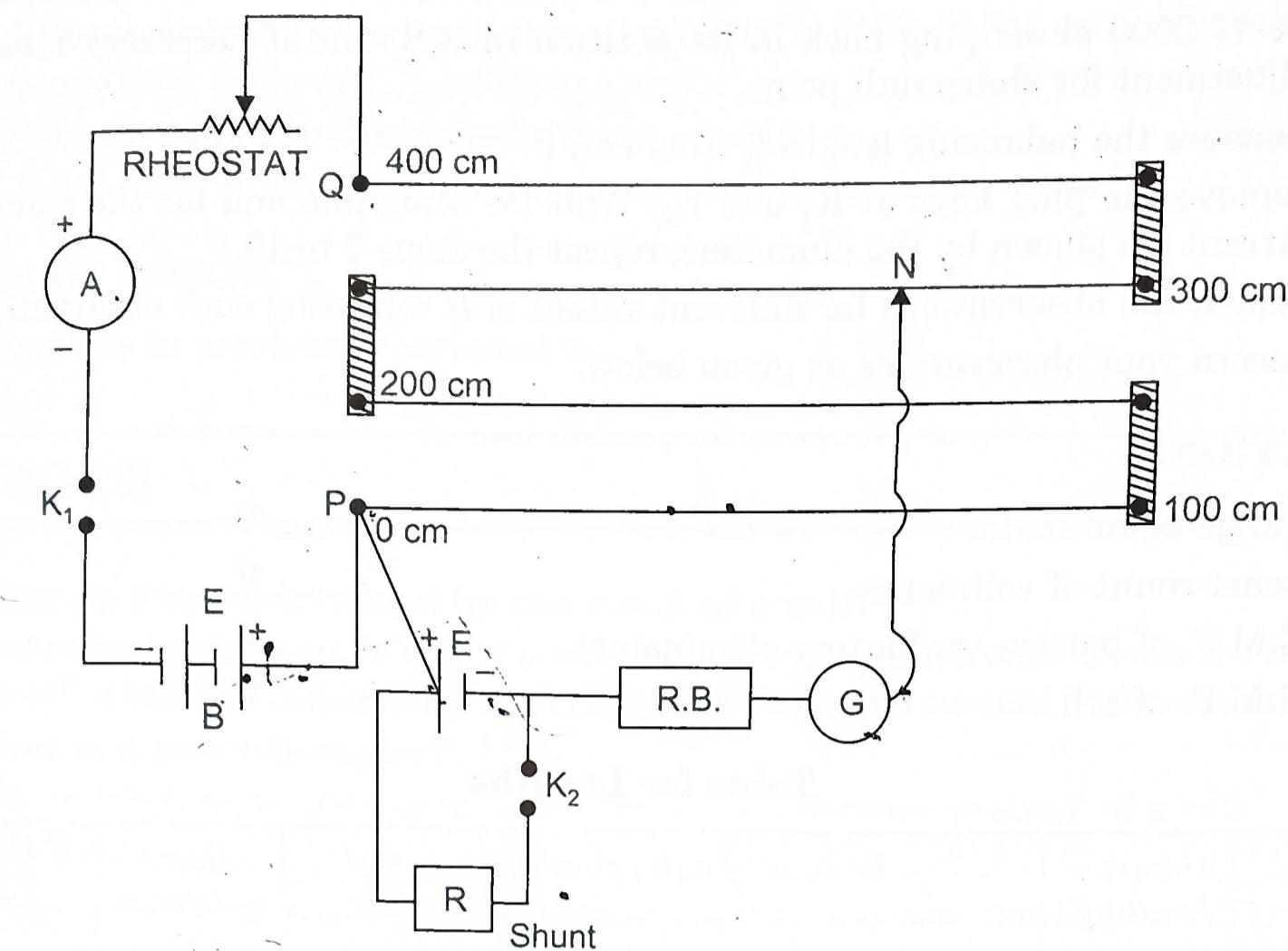


Fig. 4.03. Internal resistance of a cell.

## PROCEDURE (Stepwise)

1. Draw the circuit diagram showing the scheme of connections as in Fig. 4.03.
2. Clean the ends of the connecting wires with sand paper and make tight connections according to the circuit diagram.
3. Tight the plugs of the resistance box.
4. Check the e.m.f. of the battery and cell and see that e.m.f. of the battery is more than that of the given cell, otherwise null or balance point will not be obtained ( $E' > E$ ).
5. Take maximum current from the battery, making rheostat resistance small.
6. **To test the correctness of the connections.** (Insert the plug in the key  $K_1$  and note the ammeter reading. Take out 2000 ohm resistance plug from the resistance box. Place the jockey first at the end  $P$  of the wire and then at the end  $Q$ . If the galvanometer shows deflection in opposite directions in the two cases, the connections are correct).
7. Without inserting the plug in the key  $K_2$  adjust the rheostat so that a null point is obtained on the fourth wire of potentiometer.
8. Insert the 2000 ohm plug back in its position in resistance box and by slightly adjusting the jockey near the previously obtained position of null point, obtain the null point position accurately, using a set square.
9. Measure the balancing length  $l_1$  between this point and the end  $P$  of the wire.
10. Take out the 2000 ohms plug again from the resistance box  $R.B.$ . Introduce the plugs in key  $K_1$ , as well as in key  $K_2$ . Take out a small resistance ( $1-5 \Omega$ ) from the resistance box  $R$  connected in parallel with the cell.
11. Slide the jockey along the potentiometer wire and obtain null point.

12. Insert 2000 ohms plug back in its position in R.B. and if necessary make further adjustment for sharp null point.
13. Measure the balancing length  $l_2$  from end P.
14. Remove the plug keys at  $K_1$  and  $K_2$ . Wait for sometime and for the same value of current (as shown by the ammeter), repeat the steps 7 to 13.
15. Repeat the observations for different values of  $R$  repeating each observation twice.
16. Record your observations as given below.

### OBSERVATIONS

1. Range of voltmeter

= ..... V

Least count of voltmeter

= ..... V

E.M.F. of battery (or battery eliminator)

= ..... V

E.M.F. of cell

= ..... V

2.

Table for Lengths

Serial No. of Obs.	Ammeter Reading (A)	Position of null point (cm)						Shunt resistance $R$ (Ohm)	Internal resistance $r = \left( \frac{l_1 - l_2}{l_2} \right) \cdot R$ (Ohm)		
		Without shunt $R$			With shunt $R$						
		(i) (3a)	(ii) (3b)	Mean $l_1$ (3c)	(i) (3d)	(ii) (3e)	Mean $l_2$ (3f)				
1.											
2.											
3.											
4.											
5.											
6.											

### CALCULATIONS

1. For each set of observation find mean  $l_1$  and  $l_2$  and write in column 3c and 3f.
2. Calculate value of  $r$  for each set and write it in column 5.
3. Take mean of values of  $r$  recorded in column 5.

### RESULT

The internal resistance of the given cell is ..... ohm.

### PRECAUTIONS (to be taken)

Same as in Experiment 4 and other precautions are as:

1. The e.m.f. of the battery should be **greater than** that of the cell.
2. For one set of observation the ammeter reading should remain **constant**.
3. Current should be passed for **short time** only, while finding the null point.

4. Rheostat should be **adjusted** so that initial null point lies on last wire of the potentiometer.
5. Cell should not be **disturbed** during experiment.
6. Jockey should not be **rubbed** against the potentiometer wire.

## SOURCES OF ERROR

1. Same as in previous experiment 4.