Internal resistance by potentiometer

Object: To determine the internal resistance of Leclanche cell using potentiometer.

Apparatus Used: H.T. battery, potentiometer, galvanometer, Leclanche cell, resistance box, rheostat, keys, connecting wires.

Formula Used: The following formula is used for the determination internal resistance of Leclanche cell .

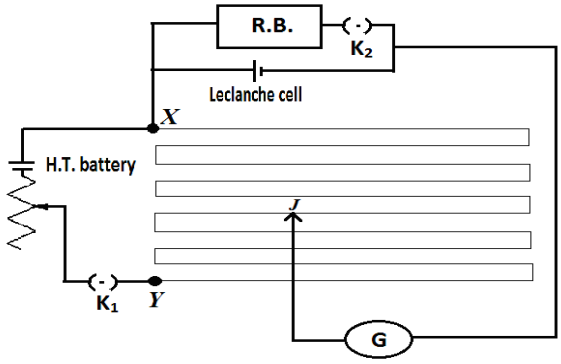
$$r = \left(\frac{l_1}{l_2} - 1\right)R$$

l_1=balancing length of potentiometer wire when Leclanche cell is open circuited with resistance box.

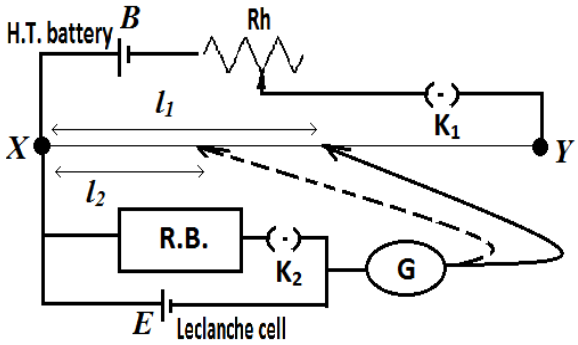
l_2=balancing length of potentiometer wire when Leclanche cell is closed circuited with resistance box.

R=Resistance applied in resistance box when Leclanche cell is closed circuited.

Circuit Diagram:



or



Here XY is potentiometer wire.

Proof: Suppose k is the potential gradient of the potentiometer wire (k=B/*l* : B: e.m.f. of H.T. battery, *l* is total length of potentiometer wire). If l_1 *is* the balancing length of potentiometer wire when Leclanche cell is open circuited with resistance box (i.e when K_1 key is pressed and K_2 key is open) then e.m.f. of Leclanche cell is equal to potential difference across l_1 length of wire. Hence,

$$E = k\, l_1 \qquad (1)$$

If r is resistance in resistance box and l_2 is balancing length of potentiometer wire when both keys K1 and K2 are pressed (i.e. Leclanche cell is closed circuited with resistance box) then potential difference (V) across R is equal to potential difference across l_2 length of wire. So,

$$V = k\, l_2 \qquad (2)$$

From equations (1) and (2) we have,

$$E/V = l_1/l_2 \qquad (3)$$

Let 'r' is internal resistance Leclanche cell. If 'i' is the current in closed circuited Leclanche cell and resistance box then from Ohm's law

$$E = i(R + r) = iR + ir = V + ir$$

$$E - V = ir$$

$$r = \frac{E-V}{i} = \frac{V}{i}\left(\frac{E}{V}-1\right) = \frac{iR}{i}\left(\frac{E}{V}-1\right) = R\left(\frac{E}{V}-1\right) \quad (4)$$

From equations (3) and (4) we have,

$$r = \left(\frac{l_1}{l_2}-1\right)R \quad (5)$$

Equation (5) is final expression of internal resistance in terms of l_1, l_2 and R.

Procedure:

1. Make connections as shown in circuit diagram. (if H.T. battery has low current supply then there is no need to connect rheostat).
2. Press the key K_1 and place the jaukey 'J' at X and Y points. If deflection in galvanometer go in opposite sides then connection is correct. If deflection goes out side of the scale of galvanometer then control it with rheostat.
3. By pressing key K_1, find the exact position on potentiometer wire at which the deflection in galvanometer is zero. Measure the distance of this point from X. This provides the length l_1.
4. Now, place a value of resistance in resistance box and press the both keys K_1 and K_2. After it, find the exact position on potentiometer wire at which the deflection in galvanometer is zero. Measure the distance of this point from X. This provides the length l_2.
5. Calculate the value of internal resistance with the given formula.
6. Repeat the process 3 to 5 for the five set of readings.

Observation:

Table for value of l_1 and l_2

Sr.No.	l_1	**R(Ω)**	l_2	**r(Ω)**
1.				
2.				
3.				
4.				
5.				

Calculation: Show all calculations for internal resistance (r) and take its mean.

Result: internal resistance of Leclanche cell= ……(Ω)

Precaution:

1. Connections should not be loose.
2. In resistance box the keys should be very tight.
3. The positive terminal of both battery and cell should be connected at same point.
4. Avoid pressing keys for large time otherwise cell will be discharged.