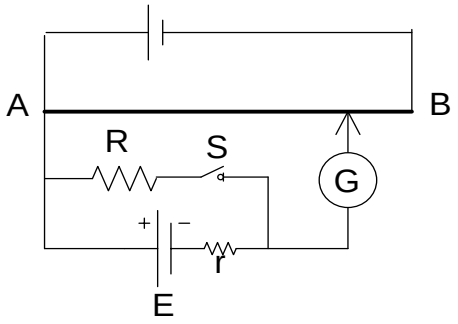
Q- The circuit below shows a circuit designed to measure the internal resistance 'r' of a battery. Resistor R is 2Ω and AB is the potentiometer wire. With the switch S open a balancing length l_1 = 55.2cm. is obtained. When switch S is closed the balancing length l_2 = 53.2cm. Calculate the internal resistance 'r' of the battery.



Let the potential gradient (rate of potential drop per unit length dV/dl) across the wire AB is ρ Volt/cm.

When the switch S is open the length of the potentiometer wire balances the EMF of the cell (as no current through the cell the cell is in open circuit) and hence we have

$E = \rho * l_1 = 55.2\ \rho$ ---------- (1)

When the switch S is closed there will be a current through the cell and the resistor R and hence the cell is in closed circuit and hence the terminal voltage V is balanced by the potentiometer wire length l_2 and hence we have

$V = \rho * l_2 = 53.2\ \rho$ ---------- (2)

Dividing the two equations we have

$E/V = 55.2/53.2 = 1.0376$

Now as the internal resistance is given by the relation

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

Substituting the values we get

$$r = 2\left(\frac{55.2}{53.2} - 1\right) = 0.0752\Omega$$