

Q- A galvanometer together with an unknown resistance in series is across two identical batteries each of EMF 1.5 V. When the batteries are connected in series, the galvanometer records a current 1A and when the batteries are in parallel, the current is 0.6 A. What is the internal resistance of each battery.

When the Batteries are in series total EMF is $2E = 3.0 \text{ V}$ and if the resistance of each battery is ' r ' the total resistance in the circuit will be in series and thus equal to $R_T = R + 2r$

$$E = I \cdot R_T = I \cdot (R + 2r)$$

Or $3.0 = 1 \cdot (R + 2r)$

Gives $R = 3.0 - 2r$ ---- (1)

When the batteries are connected in parallel the EMF will still be E and the internal resistance of the battery is $r/2$. Thus we can write

$$E = I' \cdot R_T' = I' \cdot (R + r/2)$$

Or $1.5 = 0.6 (R + r/2)$

Gives $R = 2.5 - 0.5r$

Substituting for R from equation (1) we get

$$3.0 - 2r = 2.5 - 0.5r$$

Or $1.5r = 0.5$

Or $r = 0.33 \Omega$

