Simple applications of Kirchhoff's laws

CLASS-XII

SUBJECT : PHYSICS
CHAPTER NUMBER: 03
CHAPTER NAME : CURRENT ELECTRICITY

Wheatstone Bridge:

Currents through the arms are assumed by applying Kirchhoff's Junction Rule.

Applying Kirchhoff's Loop Rule for:

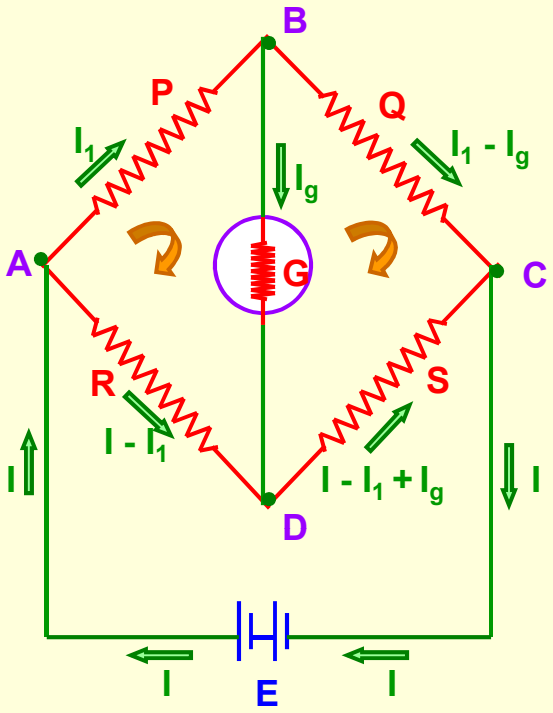
Loop ABDA:

$I_1.P + I_g.G - (I - I_1).R = 0$

Loop BCDB:

$(I_1 - I_g).Q - (I - I_1 + I_g).S - I_g.G = 0$

When $I_g = 0$, the bridge is said to balanced.



By manipulating the above equations, we get

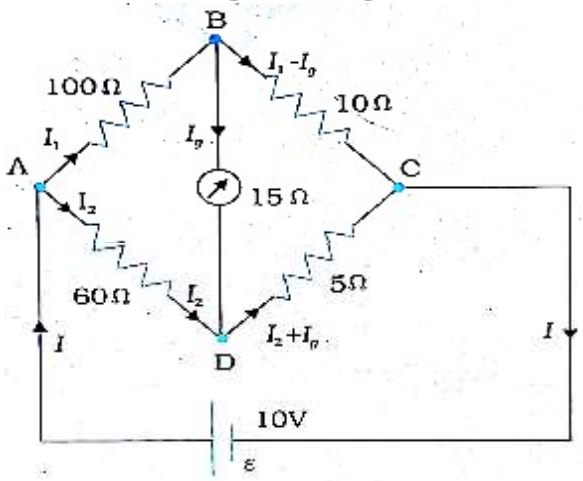
$$\frac{P}{Q} = \frac{R}{S}$$

Numerical

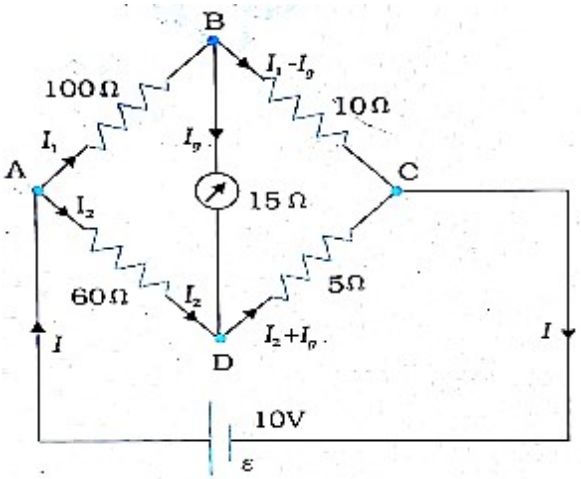
Question: The four arms of a Wheatstone bridge have the following resistances:

AB = 100Ω, BC = 10Ω, CD = 5Ω, and DA = 60Ω

A galvanometer of 15 Ω is connected across BD. Calculate the current through the galvanometer when a potential difference of 10V is maintained across AC.



Numerical



Solution: Current distribution is shown by using KCL.

Using KVL, in the loop ABDA, $100I_1 - 60(I - I_1) + 15(I_g) = 0$

$\Rightarrow -60I + 160I_1 + 15I_g = 0$ .....(i)

In the loop BCDB; $10(I_1 - I_g) - 5(I - I_1 + I_g) - 15I_g = 0$

$\Rightarrow -5I + 15I_1 - 30I_g = 0$ .....(ii)

In the loop ABCEA; $100I_1 + 10(I_1 - I_g) = 10$

$\Rightarrow 110I_1 - 10I_g = 10$ .....(iii)

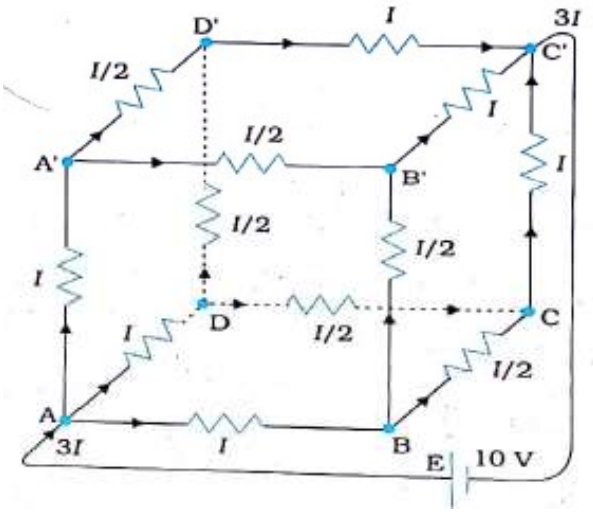
Subtracting $[12 \times equation(ii)]$ from $equation(i)$ we have

$-20I_1 + 375I_g = 0 \Rightarrow I_1 = \frac{375}{20} I_g$ .....(iv)

Using equation (iv) in equation (iii) we get ; $110 \times \frac{375}{20} I_g - 10I_g = 10 \Rightarrow I_g = 0.00487A = 4.87mA$

Numerical

Question: A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of resistance 1Ω . Determine the equivalent resistance of the network and the current along each edge of the cube.



Numerical

Question: A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of resistance 1Ω . Determine the equivalent resistance of the network and the current along each edge of the cube.

Solution :

The current is distributed using symmetry and KCL.

Using KVL in the loop ABCC'EA; $1.I + 1.I/2 + 1.I = 10$

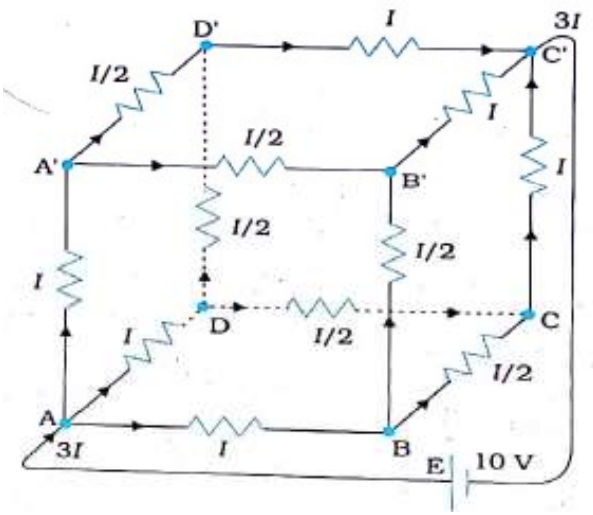
$$\Rightarrow I = 4A$$

Total current entering into the network $= 3I = 12A$

$$\therefore R_{eq} = \frac{V}{3I} = \frac{10V}{12A} = \frac{5}{6}\Omega$$

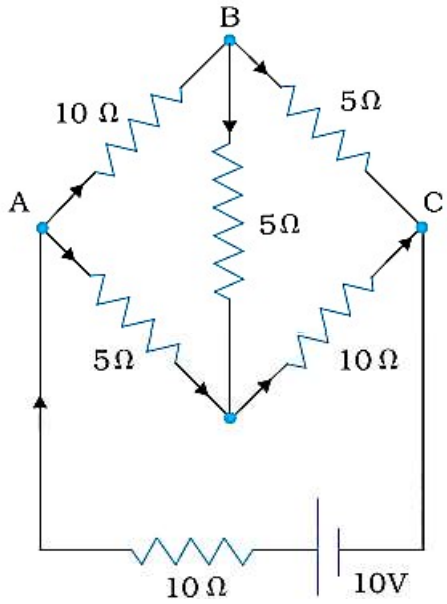
Now currents along arms AB, AD, AA', D'C', BC', CC'=4A

Currents through arms; DC, DD', BC, BB', A'B', A'D'=I/2=2A



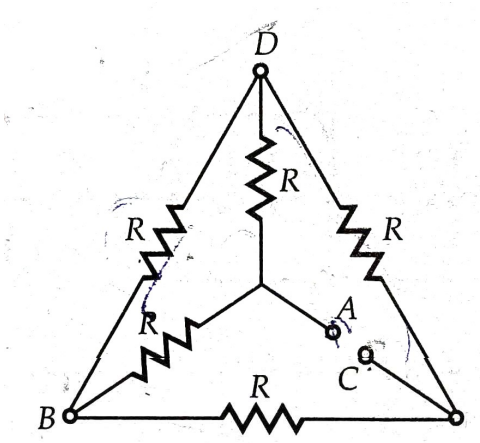
Numerical

Question: Determine the current in each branch of the network shown in the figure.(NCERT)



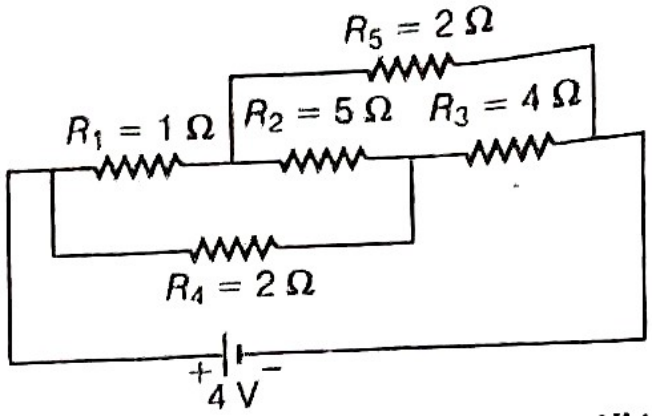
Numerical

Question: Each of the resistance in the network equals R. find the resistance between two terminals A and C



HOME ASSIGNMENT

1. Calculate the current drawn from the battery in the given network



2. Answer the following:

   a) State Kirchhoff's rules.

   b) A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of 1Ω resistance. Use Kirchhoff's rules to determine

      i. the equivalent resistance of the network and

      ii. the total current in the network

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Home Assignment

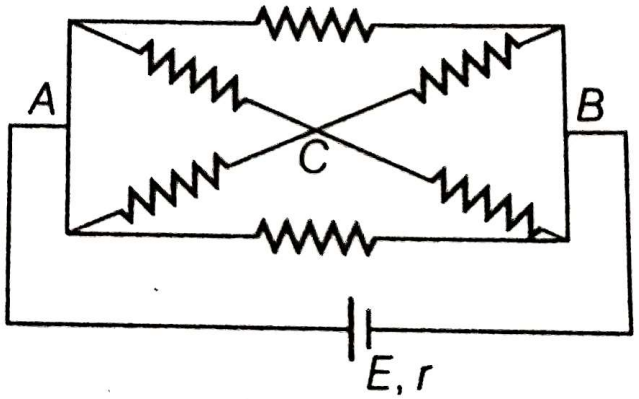
3. Answer the following:

   a) State the two Kirchhoff s laws. Explain briefly, how these rules are justified?

   b) The current is drawn from a cell of emf E and internal resistance r connected to the network of resistors each of resistance r as shown in the figure. Obtain the expression for

      i. the current draws from the cell and

      ii. the power consumed in the network.



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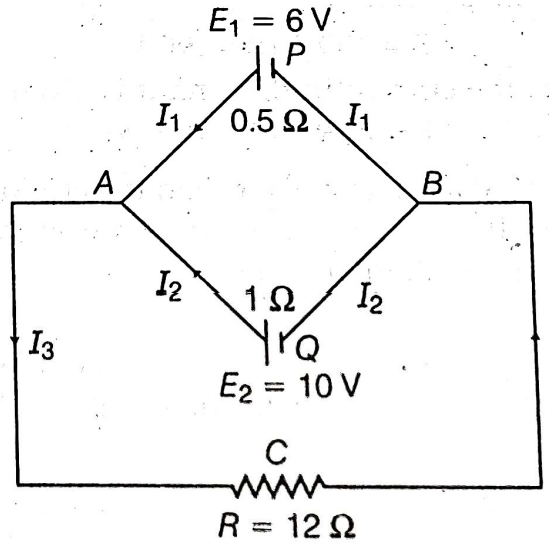
Home Assignment

4. State Kirchhoff's rules. Apply Kirchhoff's rules to the loops .ACBPA and ACBQA to write the expressions for the currents I_1, I_2 and I_3 in the network.



THANKING YOU

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