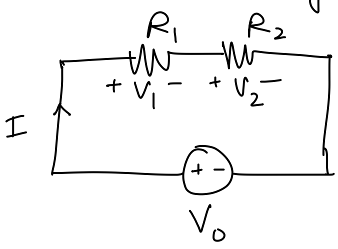
RESISTANCE :-

Connectivity → Series. / parallel. } ckt will be governed by ohm law.

$V \propto I$.

$\boxed{V = IR}$

① Series –
- Current will remain same.
- Voltage gets divided.



$V_0 = V_1 + V_2$.

$I R_{eq} = I R_1 + I R_2$

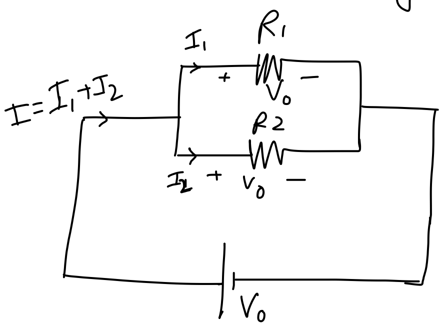
$\boxed{R_{eq} = R_1 + R_2}$

$V_1 = I R_1$

$V_2 = I R_2$

$V_0 = I R_{eq}$.

② parallel –
- Current gets divided.
- Voltage remains same.



$I = I_1 + I_2$.

$\frac{V_0}{R_{eq}} = \frac{V_0}{R_1} + \frac{V_0}{R_2}$.

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$.

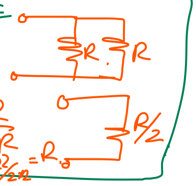
$\boxed{R_{eq} = \frac{R_1 R_2}{R_1 + R_2}}$

$V_0 = I_1 R_1 \Rightarrow I_1 = \frac{V_0}{R_1}$

$V_0 = I_2 R_2 \Rightarrow I_2 = \frac{V_0}{R_2}$.

$V_0 = I R_{eq} \Rightarrow I = \frac{V_0}{R_{eq}}$

NOTE

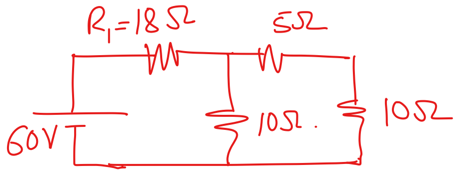


$R_{eq} = \frac{RR}{R+R} = \frac{R^2}{2R} = \frac{R}{2}$

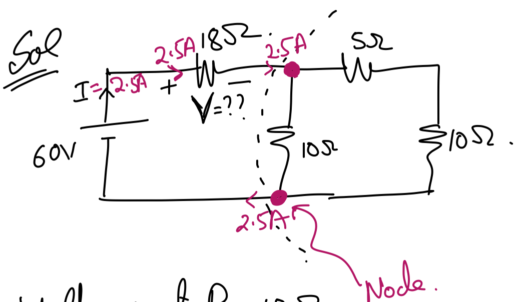
For 3 Resistance

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow \boxed{R_{eq} = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}}$

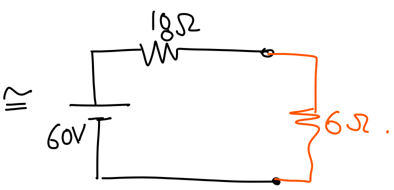
Q Determine the Voltage drop of R_1:

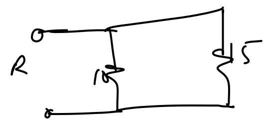


Sol

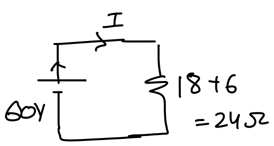


$\simeq$





$R = \frac{10 \times 15}{25} = 6\Omega$.



$V = IR$

$60 = I \times 24 \leadsto I = \frac{60}{24} = \frac{5}{2} = 2.5\,A$.

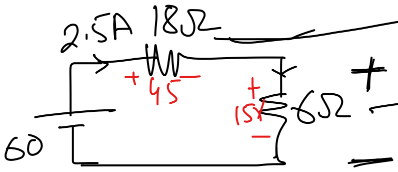
Voltage at $R_1 = 18\Omega$.

$V = I \times R_{18\Omega}$.

$= 2.5 \times 18$.

$= 45V$

Another method.



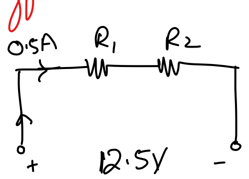
$\longrightarrow V = IR$
$= 2.5 \times 6$
$= 15V$

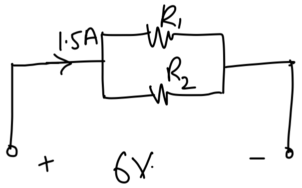
$V = IR$
$= 2.5 \times 18$
$= 45V$

$\boxed{60V = 45V + 15V}$

Q When a current of 0.5A is passed through two resistances in series, the potential difference between the ends of the series arrangement is 12.5V. On connecting them in parallel and passing a current of 1.5A, the potential difference between their ends is 6V. Calculate the two Resistances.

Sol





$V = IR$

$12.5 = 0.5 R_{eq}$

$12.5 = 0.5(R_1 + R_2)$

$R_1 + R_2 = \frac{\cancel{12.5}}{\cancel{.5}} = 25$

$R_1 + R_2 = 25$ —— ①

$V = IR$

$6 = 1.5 \times R_{eq}$

$\frac{6}{1.5} = \frac{R_1 R_2}{R_1 + R_2}$

$4(R_1 + R_2) = R_1 R_2$ —— ②

① $\longrightarrow$ ②

$4(25) = R_1 R_2$

$R_1 R_2 = 100$

$R_2 = \frac{100}{R_1}$ —— ③

③ $\longrightarrow$ ①

$R_1 + \frac{100}{R_1} = 25$

$R_1^2 + 100 = 25 R_1 \quad = \quad R_1^2 - 25R_1 + 100 = 0$

$R_1^2 - 5R_1 - 20R_1 + 100 = 0$

$R_1(R_1 - 5) - 20(R_1 - 5) = 0$

$(R_1 - 5)(R_1 - 20) = 0$

$R_1 = 5\Omega$ or 20Ω

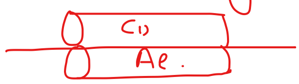
Comment

① If $R_1 = 5\Omega$ then $R_2 = 20\Omega$.

② If $R_1 = 20\Omega$, $R_2 = 5\Omega$.

Ans

Q A Cu rod of length 20cm and Cross-sectional area $2\,mm^2$ is joined with a similar Al rod as shown. Find the resistance of Combination between the ends. $\rho_{Cu} = 1.7 \times 10^{-8}\,\Omega m$ and $\rho_{Al} = 2.6 \times 10^{-8}\,\Omega m$.



Sol $R = \frac{\rho l}{A}$

$R_{Cu} = \frac{\rho_{Cu} l}{A} = \frac{1.7 \times 10^{-8} \times 20 \times 10^{-2}}{2 \times 10^{-6}} = 17 \times 10^{-4}\,\Omega$

$$R_{Al} = \frac{\rho_{Al}\, l}{A} = \frac{2.6\times10^{-8} \times 20\times10^{-2}}{2\times10^{-6}} = 26\times10^{-4}\,\Omega$$

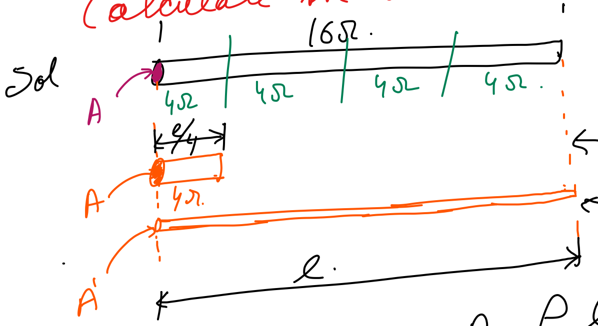
From the fig Cu and Al pieces are connected parallel.

$$R_{eq} = \frac{R_{Cu}\,R_{Al}}{R_{Cu}+R_{Al}} = \frac{17\times26\times10^{-8}}{43\times10^{-4}} = \frac{17\times26}{43}\times10^{-4}\,\Omega$$

$$= 10.279\times10^{-4}\,\Omega \text{ Ans}$$

Q A wire of uniform cross section and length l has a resistance of 16 Ω. It is cut into 4 equal parts. Each part is stretched uniformly to length l and all the 4 stretched part are connected in parallel. Calculate the total resistance of the combination so formed.

Sol



Volume of ¼ wire will be same that of stretched length 'l'.

$$V = A\,l$$

$$A \times \frac{l}{4} = A' \times l$$

$$A' = \frac{A}{4}$$

$$R = \frac{\rho l}{A}$$

$$R = \frac{\rho\, l/4}{A}$$

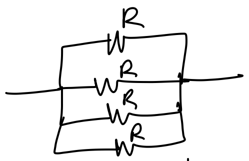
$$R' = \frac{\rho\, l}{A'}$$

$$\frac{R}{R'} = \frac{A'}{4A} = \frac{A/4}{4A} = \frac{1}{16} \Rightarrow R' = 16R$$

$R = 16\,\Omega$ given.

$$= 16(4)$$

$$R' = 64\,\Omega$$

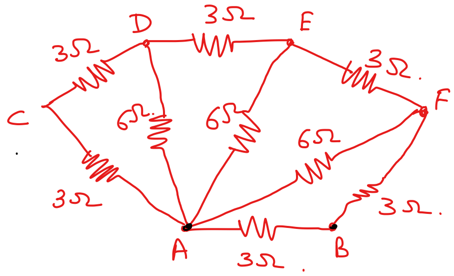


$$R_{eq} = \frac{64}{4} = 16\,\Omega \text{ Ans}$$

$$\frac{1}{R_{eq}} = \frac{1}{64}+\frac{1}{64}+\frac{1}{64}+\frac{1}{64}$$

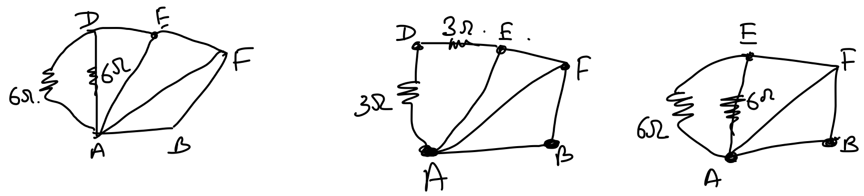
$$\frac{1}{R_{eq}} = \frac{\cancel{4}}{\cancel{64}_{16}} \quad \therefore R_{eq} = 16\,\Omega \text{ Ans}$$

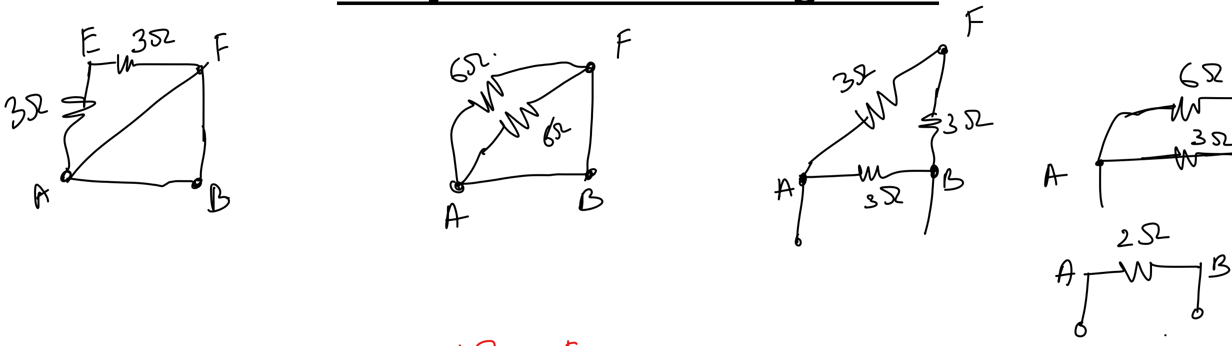
Q Find R_{AB}



Sol Solving ACD 3 + 3 = 6.

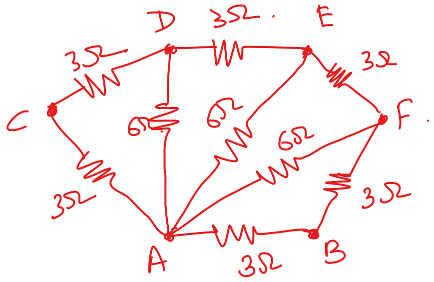
ACD // AD.





$\frac{3\times6}{9} = 2\Omega$ Ans

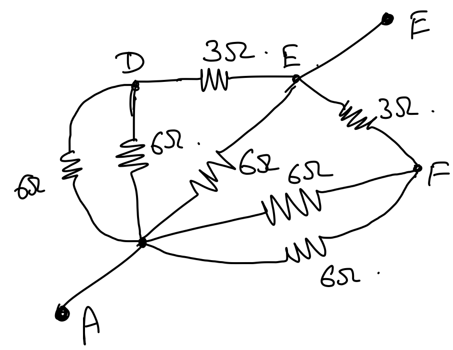
R_{AE} = ??



Sol

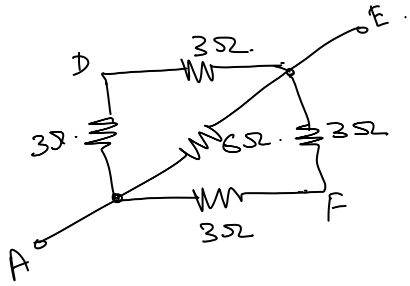
ACD = 3+3 = 6Ω.

ABF = 3+3 = 6Ω.



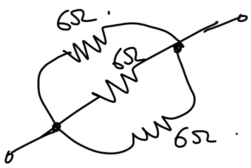
AF = 6//6 = 3Ω.

AD = 6//6 = 3Ω.



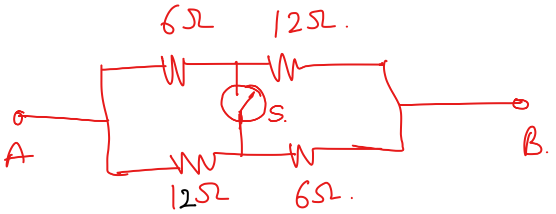
ADE = 3+3 = 6

AFE = 3+6 = 6

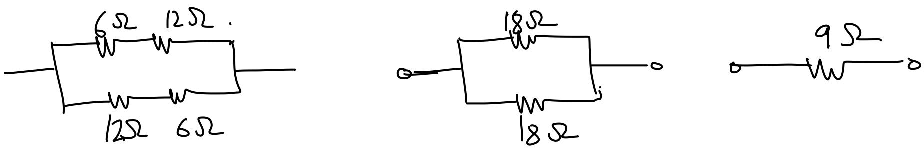


$R_{eq} = \frac{6}{3} = 2\Omega$ Ans

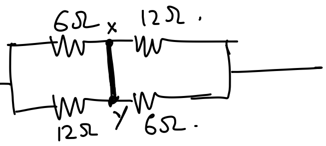
Q Find R_{AB} for ① Switch open. ② Switch closed.



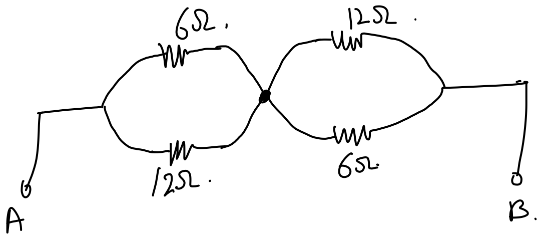
Case I Switch open



Case II Switch closed

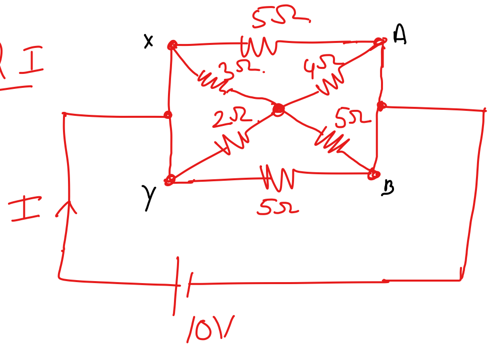


There is only wire between x and y. ∴ the points x and y are at equipotential. we may combine these two points (xy) as shown.

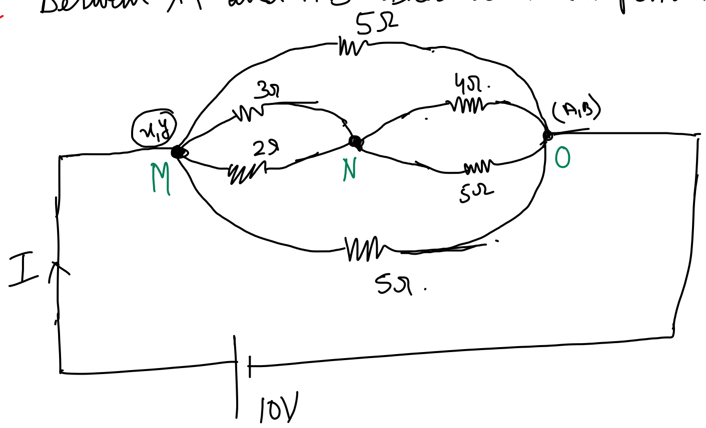


$$R_{AB} = \frac{6\times 12}{6+12} + \frac{6\times 12}{6+12}$$
$$= \frac{\cancel{6}\times\cancel{12}}{\cancel{18}} + 4 = 4+4 = 8\,\Omega.$$

Q Find I



Sol between XY and AB there is no component. ∴ X and Y, A and B can be combined together.



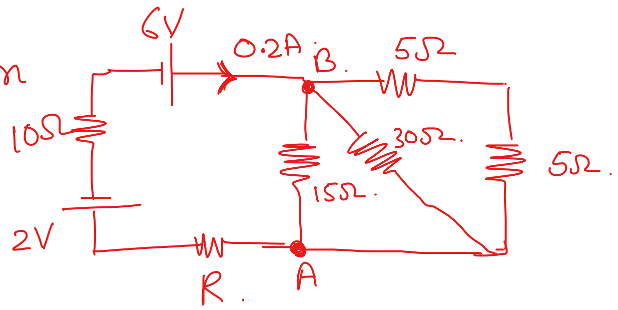
$$MN = \frac{3\times 2}{5} = \frac{6}{5}\,\Omega.$$
$$ON = \frac{4\times 5}{9} = \frac{20}{9}\,\Omega.$$
$$MNO = \frac{6}{5} + \frac{20}{9}$$
$$= \frac{54+100}{45} = \frac{154}{45}\,\Omega.$$

$$\frac{1}{R_{eq}} = \frac{1}{5} + \frac{1}{154/45} + \frac{1}{5}.$$
$$= \frac{2}{5} + \frac{45}{154} = \frac{533}{770}.$$
$$R_{eq} = \frac{770}{533} = 1.44\,\Omega.$$

$V = IR,$

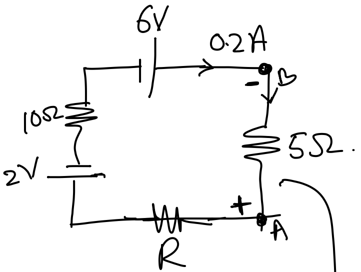
$10 = I\times R_{eq} \Rightarrow I = \frac{10\times 533}{770} = 6.92\,A$ Ans

Q For the fig shown
① Find R.
② Find V_{AB}.

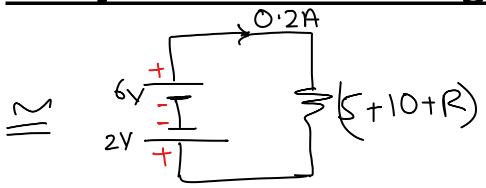


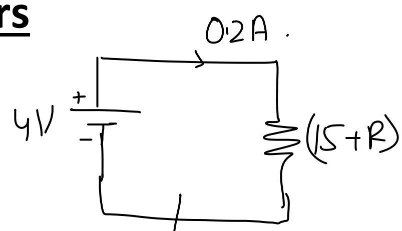
Sol Solving left of AB

$5+5 = 10\,\Omega \longrightarrow \frac{10\times 30}{40} = \frac{15}{2} \longrightarrow \frac{15\times 15/2}{15+\frac{15}{2}} = \frac{\cancel{15}\times 15}{\cancel{45}}$
$= \frac{15}{3} = 5\,\Omega.$



$\simeq$



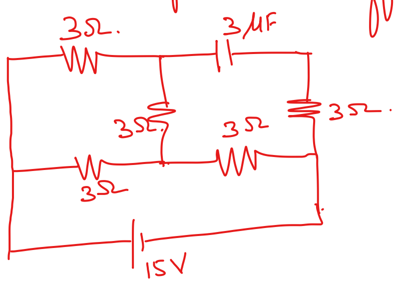


Since 6V and 2V are connected with opposite polarity. The resultant Voltage is the difference between then $(6-2)=4$

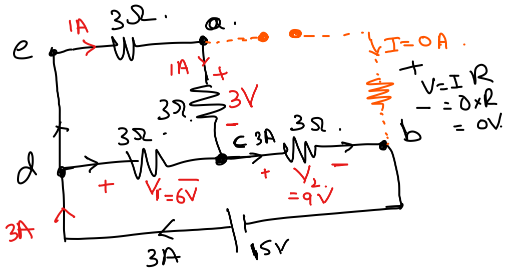
$$V_{AB} = -0.2\times 5 = -1V \text{ Ans}$$

$$V = IR.$$
$$4 = 0.2(15+R)$$
$$4 = 3 + 0.2R.$$
$$0.2R = 1 \therefore R = \frac{1}{0.2} = \frac{10}{2}$$
$$R = 5\Omega \text{ Ans}$$

Q Find the potential difference across the Capacitor.



Sol Capacitor passes AC and block DC and in this ckt it has 15 DC. ∴ Capacitor will not conduct current once it reaches steady state. It behaves like a open ckt as shown in fig:-



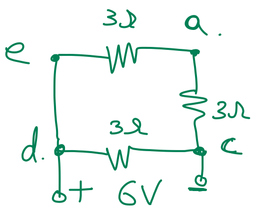
$$R_{eq} = 6//3 + 3$$
$$= \frac{6\times 3}{9} + 3$$
$$= 5\Omega.$$

To find V_{ab} = ??

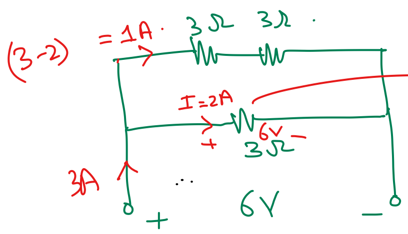
$$V_1 + V_2 = 15.$$

$$V = I \times R$$
$$15 = I \times R_{eq}$$
$$I = \frac{15}{5} = 3A$$

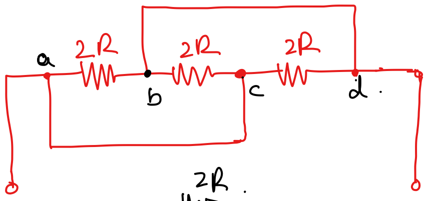
$$V_2 = I\times 3.$$
$$V_2 = 3\times 3$$
$$= 9V$$



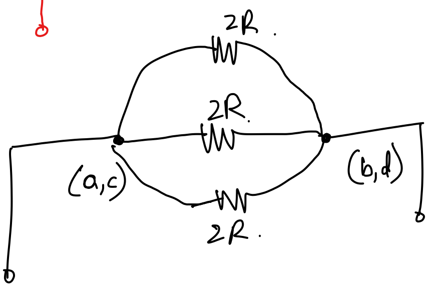
$$V_{ab} = 3+9$$
$$= 12V. \text{ Ans}$$



$$V = IR$$
$$6 = I\times 3$$
$$I = 2A.$$

Q 

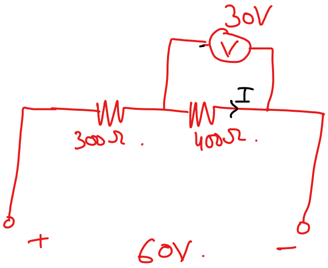
Find R_{eq}

Sol 

$$\frac{1}{R_{eq}} = \frac{1}{2R} + \frac{1}{2R} + \frac{1}{2R}$$

$$\frac{1}{R_{eq}} = \frac{3}{2R}$$

$$R_{eq} = \frac{2R}{3}$$ Ans

Q 

Find Voltage at 300Ω.

Sol $V = IR$

$30 = I \times 400$

$I = \frac{3\cancel{0}}{40\cancel{0}} = \frac{3}{40}\ A$.

$V_{300\Omega} = I \times R_{300\Omega}$

$= \frac{3}{\cancel{40}_{2}} \times \cancel{300}^{15} = \frac{45}{2}$.

$V_{300\Omega} = 22.5\ V$ Ans

Heating effect :-

Heat energy (H) (loss) [Work done] $\Rightarrow$ $\boxed{H = VI \cdot t = I^2 R \cdot t = \frac{V^2}{R} \cdot t}$

$$\text{Power} = \frac{\text{Work}}{\text{time}} = \frac{H}{t} \Rightarrow \boxed{P = VI = I^2 R = \frac{V^2}{R}}$$

Power

$1\,kW = 1000\,W$

$1\,MW = 10^6\,W$

$1\,hp = 746\,W$

↳ horse power

Energy

$1\,kWhr = 1\,kW \times 1\,hour$

$= 1000\,W \times 3600\,s$

$\boxed{1\,kWhr = 3600000\,J}$

$= 3.6 \times 10^6\,J \longrightarrow$ Commercial Unit of Electric Energy

1 watt hour $= 1$ watt $\times 1\,hr = 3.6 \times 10^6\,J$ (sic; $1\,Wh = 3600\,J$).

$4.18\,J = 1\,Cal$

Power Rating :-

Electric energy consumed per second when connected across the rated voltage of the main supply.

Q How many electrons flow through the filament of a 120V and 60W electric lamp per second?

Sol

$$I = \frac{q}{t} = \frac{ne}{t}$$

$t = 1\,s$

$e = 1.6 \times 10^{-19}\,C$

$P = 60\,W$

$V = 120$

$P = VI$

$\cancel{60} = \cancel{120}^{2} \times I$

$I = \frac{1}{2}\,A$

$$n = \frac{It}{e}$$

$$= \frac{1}{2 \times 1.6 \times 10^{-19}}$$

$$= \frac{1}{3.2} \times 10^{+19} = \frac{10}{32} \times 10^{+19} = \frac{100}{32} \times 10^{18}$$

$$= 3.125 \times 10^{18} \text{ electrons}$$ **Ans**

Q An electric motor operates on a 50V supply and draws a current of 12A. If the motor gives a mechanical o/p of 150W. What is the % efficiency of motor?

Sol

$$\eta = \frac{\text{O/p Power}}{\text{I/p Power}} = \frac{ME}{EE}$$

I/p $\Rightarrow$ $V = 50\,V$; $I = 12\,A$

$P_{elect} = VI = 50 \times 12 = 600\,W$

$EE \longrightarrow \boxed{\text{Motor}} \longrightarrow ME$

$$\eta = \frac{\cancel{150}}{\cancel{600}_{4}} \times 100 = 25\%$$ **Ans**

Q An electric Power station 100 MW transmits power. Find lesser Power wastage for them ① 20,000V
② 200V ??

Comment on the result.

Sol $P = 100\,MW = 100 \times 10^6\,W.$

$\boxed{loss = I^2 R.}$

① $V = 20{,}000V.$
$P = 100 \times 10^6\,W$

$P = VI.$
$I = \frac{\cancel{100}^{5} \times \cancel{1000} \times 10^3}{\cancel{20{,}000}}.$
$I = 5\,KA = 5000\,A$

$loss. = (5000)^2 \times R.$
$loss. = 25R \times 10^6 \cdot W = P_{20K}.$

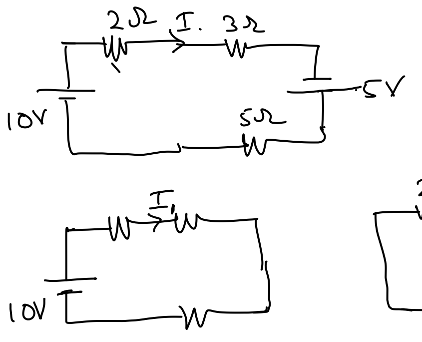
② $V = 200\,V$
$P = 100 \times 10^6\,W$

$P = VI.$
$I = \frac{\cancel{100} \times 10^6}{2\cancel{00}} = 0.5 \times 10^6\,A$

$loss = (.5 \times 10^6)^2 \times R.$
$= 0.25 \times 10^{12} \times R.$
$loss. = 250000R \times 10^6\,W = P_{200}$

loss when V = 20KV is much less than V = 200V supply. Lesser the Value of loss better it is. ∴ High Voltage transmission is always good for low losses.

KVL and KCL → KIRCHHOFF'S LAWS



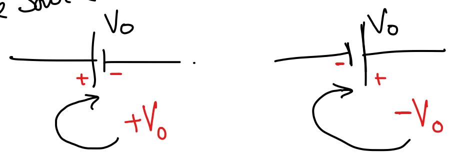
Using ohm's law in a circuit having more than 1 Sources is lengthy to Solve.
∴ we prefer Kirchhoff's law.

$$I = I_1 + I_2$$

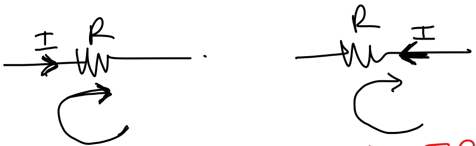
Rules to be followed :—

KVL ① loop → closed path.

② Voltage Source.

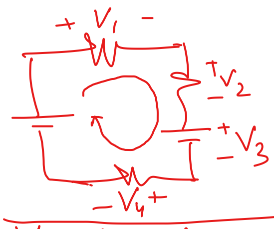


③



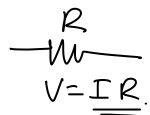
$V = +IR$. $V = -IR$.

Voltage Law

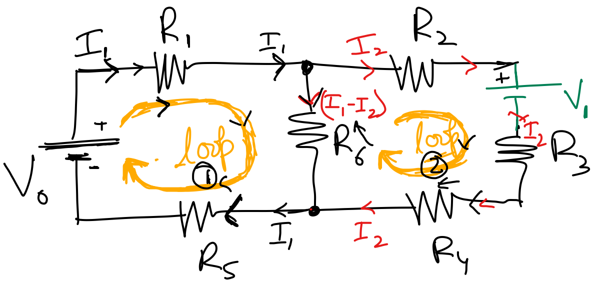


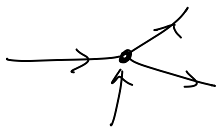
$$\boxed{V_1 + V_2 + V_3 + \cdots\cdots = 0}$$

K.V.L



Q



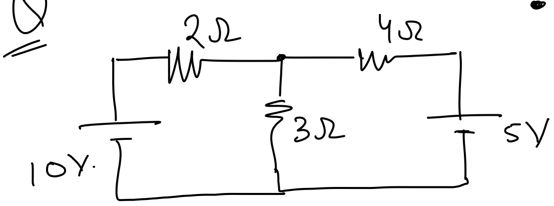


Node → Junction Point

$$\rightarrow \underbrace{+I_1R_1}_{V_{R_1}} + \underbrace{(I_1-I_2)R_6}_{V_{R_6}} + \underbrace{I_1R_5}_{V_{R_5}} - V_0 = 0 \quad \text{—— ①}$$

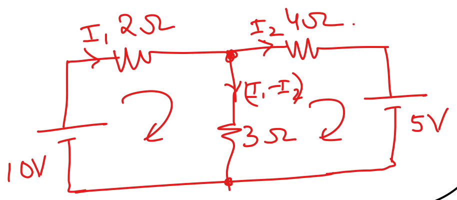
$$+I_2R_2 + V_1 + I_2R_3 + I_2R_4 - (I_1-I_2)R_6 = 0 \quad \text{—— ②}$$

Q



• Find the Voltage and Current across each element.

Sol



$2I_1 + 3(I_1 - I_2) - 10 = 0$

$4I_2 + 5 - 3(I_1 - I_2) = 0$

$I_1 = \frac{23}{12}$ A

$I_2 = -\frac{5}{36}$ A

$4I_2 + 5 - 3I_1 + 3I_2 = 0$

$-3I_1 + 7I_2 = -5$

$3I_1 - 7I_2 = 5$ — (2) × 3.

$2I_1 + 3I_1 - 3I_2 = 10$

$5I_1 - 3I_2 = 10$ — (1) × 7.

$9I_1 - 21I_2 = 15$

$\underline{-}\ 35I_1 \overset{+}{-} 21I_2 = \underline{-}70$

$-26I_1 = -55$

$\boxed{I_1 = \frac{55}{26} \text{ A}}$ → elim

$5\left(\frac{55}{26}\right) - 3I_2 = 10$

$I_2 = \frac{5}{26}$ A

Or

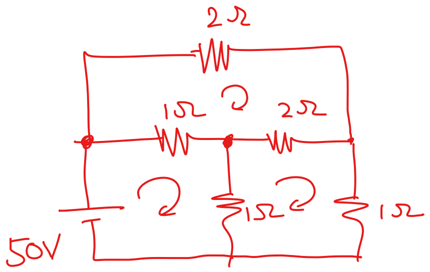
$3I_1 = 5 + 7I_2$

$I_1 = \frac{5 + 7I_2}{3}$ → Sub

$5\left[\frac{5+7I_2}{3}\right] - 3I_2 = 10$

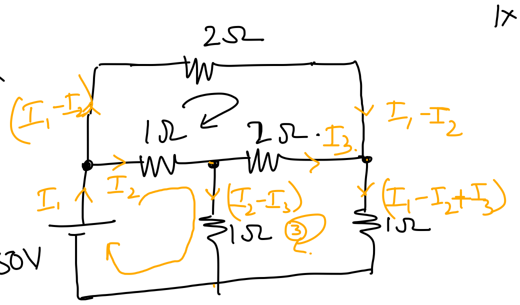
Solve

#



Find the current in each element.

Sol



$1 \times I_2 + 1(I_2 - I_3) - 50 = 0$

$2I_2 - I_3 = 50$

$I_3 = 2I_2 - 50$ — (1)

$2(I_1 - I_2) - 2I_3 - 1I_2 = 0$

$2I_1 - 3I_2 - 2I_3 = 0$ — (2)

$2I_3 + 1(I_1 - I_2 + I_3) - 1(I_2 - I_3) = 0$

$I_1 - 2I_2 + 4I_3 = 0$ — (3)

Putting ① in ②

$$2I_1 - 3I_2 - 2[2I_2 - 50] = 0.$$

$$2I_1 - 7I_2 = -100.$$

$$I_2 = \frac{2I_1 + 100}{7} \quad \text{—— ④} = \frac{2 \times \frac{800}{19} + 100}{7} = \frac{1600 + 1900}{7 \times 19} = \frac{\overset{500}{\cancel{3500}}}{\cancel{7} \times 19} = \frac{500}{19} A$$

Putting ① in ③

$$I_1 - 2I_2 + 4(2I_2 - 50) = 0$$

$$I_1 + 6I_2 - 200 = 0$$

$$I_2 = \frac{200 - I_1}{6}. \quad \text{—— ⑤} = \frac{200 - \frac{800}{19}}{6.} = \frac{3800 - 800}{6 \times 19} = \frac{\overset{500}{\cancel{3000}}}{\cancel{6} \times 19} = \frac{500}{19} A$$

Equating ④ and ⑤.

$$\frac{2I_1 + 100}{7} = \frac{200 - I_1}{6.}$$

$$12I_1 + 600 = 1400 - 7I_1$$

$$19I_1 = 800.$$

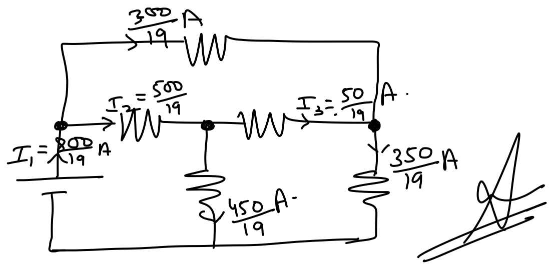
$$I_1 = \frac{800}{19} A$$

From Eq ⑤ $\quad I_2 = \dfrac{200 - 800/19}{6} = \dfrac{3800 - 800}{19 \times 6} = \dfrac{\overset{500}{\cancel{3000}}}{19 \times \cancel{6}} = \dfrac{500}{19} A.$

From Eq ① $\quad I_3 = (2I_2 - 50)$

$$= 2\left(\frac{500}{19}\right) - 50 = \left(\frac{1000 - 950}{19}\right) = \frac{50}{19} A.$$

$$I_1 = \frac{800}{19} A \quad : \quad I_2 = \frac{500}{19} A \quad I_3 = \frac{50}{19} A.$$

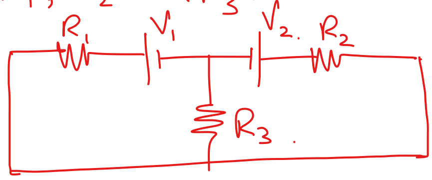


$$I_1 - I_2 = \frac{800}{19} - \frac{500}{19} = \frac{300}{19} A$$

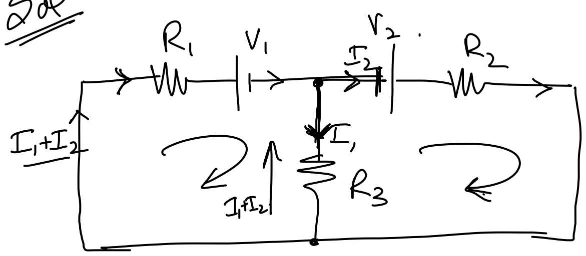
$$I_2 - I_3 = \frac{500}{19} - \frac{50}{19} = \frac{450}{19} A$$

$$I_1 - I_2 + I_3 = \frac{800}{19} - \frac{500}{19} + \frac{50}{19} = \frac{800 - 500 + 50}{19} = \frac{350}{19} A.$$

Q Determine the Current through the resistance R_1, R_2 and R_3.



Sol



$$R_1(I_1 + I_2) + V_1 + R_3 I_1 = 0.$$

$$(R_1 + R_3)I_1 + R_1 I_2 = -V_1 \quad \text{—— ①}.$$

$$-V_2 + R_2 I_2 - R_3 I_1 = 0.$$

$$I_2 = \frac{V_2 + R_3 I_1}{R_2} \quad \text{—— ②}$$

Putting ② → ①

$$(R_1+R_3)I_1 + R_1\left(\frac{V_2+R_3I_1}{R_2}\right) = -V_1$$

$$\left[R_1+R_3+\frac{R_1R_3}{R_2}\right]I_1 + \frac{R_1}{R_2}V_2 = -V_1$$

$$(R_1R_2+R_2R_3+R_1R_3)\,I_1 + R_1V_2 = -V_1R_2 .$$

$$I_1 = -\left[\frac{V_1R_2+V_2R_1}{R_1R_2+R_2R_3+R_1R_3}\right] \longrightarrow \text{Current through } R_3$$

Putting I_1 in eq ②.

$$I_2 = \frac{V_2}{R_2} + \frac{R_3}{R_2}\left[\frac{-V_1R_2-V_2R_1}{R_1R_2+R_2R_3+R_1R_3}\right].$$

$$= \frac{1}{R_2}\left[\frac{R_1R_2V_2+R_2R_3V_2+\cancel{R_1R_3V_2}-R_2R_3V_1-\cancel{R_1R_3V_2}}{R_1R_2+R_2R_3+R_1R_3}\right]$$

$$I_2 = \left[\frac{(R_1+R_3)V_2-R_3V_1}{R_1R_2+R_2R_3+R_1R_3}\right]$$ Current through R_2.

$$I_1+I_2 = \frac{-(V_1R_2+V_2R_1)}{R_1R_2+R_2R_3+R_1R_3} + \frac{(R_1+R_3)V_2-R_3V_1}{R_1R_2+R_2R_3+R_1R_3}$$

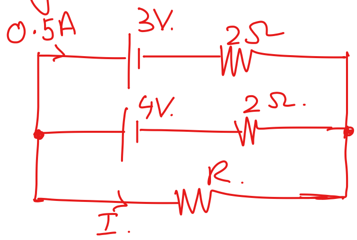
$$= \frac{-V_1R_2-\cancel{V_2R_1}+\cancel{R_1V_2}+R_3V_2-R_3V_1}{R_1R_2+R_2R_3+R_1R_3}$$

$$I_1+I_2 = \frac{-V_1(R_2+R_3)+V_2R_3}{R_1R_2+R_2R_3+R_1R_3} = -\left[\frac{V_1(R_2+R_3)-V_2R_3}{R_1R_2+R_2R_3+R_1R_3}\right]$$

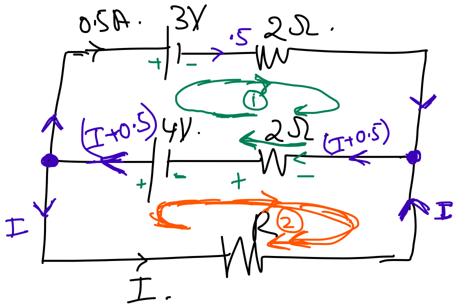
↳ Current through R_1.

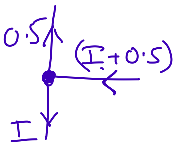
\# Using KIRCHHOFF's rule find ① Voltage across R.
② Current I.

– 2011 ④.



Sol





$+2(I+0.5)-4+3+2(0.5)=0$

$2I+1-4+3+1=0$

$2I-4+5=0$

$2I+1=0$

$I=-\frac{1}{2}\,A$

$+4-2(I+0.5)-RI=0$

$4-2I-1-RI=0$

$3=(2+R)I \longrightarrow 3=(2+R)\left(\frac{-1}{2}\right)$

$-6=2+R$

$R=-8\,\Omega$

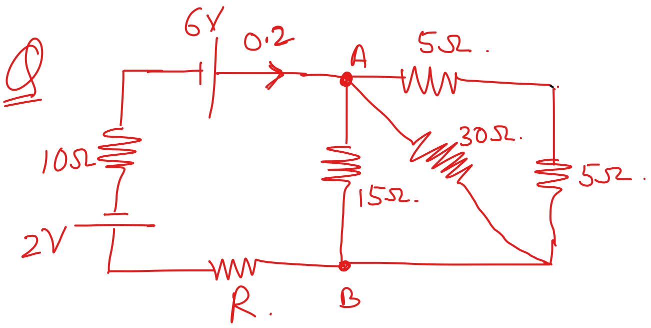
$V=I\times R$

$V_R=I\times R$

$=\left(-\frac{1}{2}\right)\times(-8)$

$\boxed{V_R=4V}$

Q



Find R, so that the current $I=0.2A$.
What is the potential between the point AB.

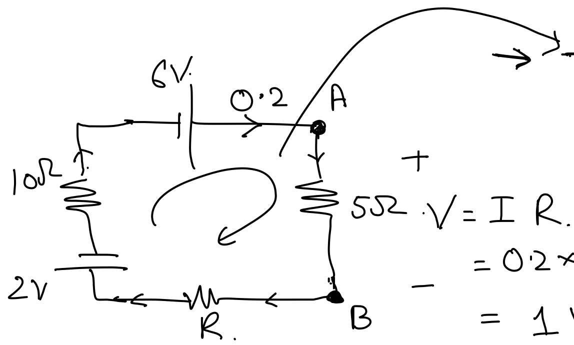
2012 ③.

Sol

$5+5=10\Omega$

$10\Omega \,//\, 30\Omega = \frac{10\times 30}{40} = 7.5\Omega$

$7.5 \,//\, 15 = \frac{7.5\times 15}{7.5+15} = 5\Omega$



$-6+(0.2\times 5)+0.2R$
$+2+10(0.2)=0$

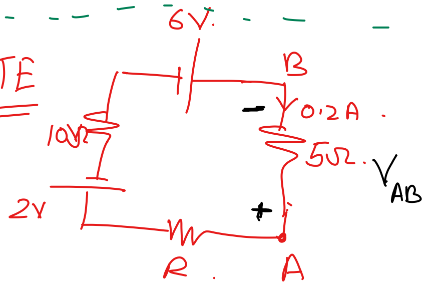
$R=5\,\Omega$

$V=IR$

$=0.2\times 5$

$=1V$

NOTE



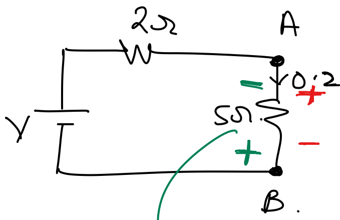
Find V_{AB}.

Sol

$V_{AB}=-(0.2)\times(5)$

$=-1V$

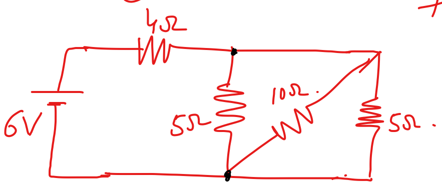
Q



$V = 0.2 \times 5 = 1V = V_{AB}$

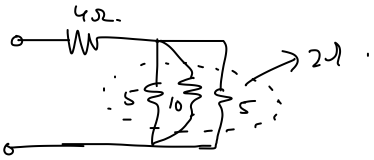
$V = (-0.2) \times 5 = -1V = V_{BA}$

Q 2011 (4)



Find
1. R_{eq}
2. Current in each element.

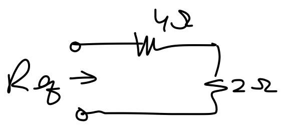
Sol



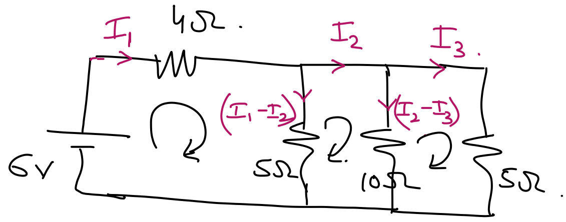
$$\frac{1}{R} = \frac{1}{5} + \frac{1}{10} + \frac{1}{5}$$

$$\frac{1}{R} = \frac{2+1+2}{10} = \frac{\cancel{5}}{\cancel{10}\,2}$$

$R = 2\Omega$



$$R_{eq} = 4 + 2 = 6\Omega$$ Ans



$4I_1 + 5(I_1 - I_2) - 6 = 0$ —— (1)

$9I_1 - 5I_2 = 6$ —— (1)

$10(I_2 - I_3) - 5(I_1 - I_2) = 0$ —— (2)

$2I_2 - 2I_3 - I_1 + I_2 = 0$

$-I_1 + 3I_2 - 2I_3 = 0$ —— (2)

$5I_3 - 10(I_2 - I_3) = 0$ —— (3)

$I_3 - 2I_2 + 2I_3 = 0$

$-2I_2 + 3I_3 = 0$

$I_3 = \frac{2}{3} I_2$ —— (3)

(3) $\rightarrow$ (2)

$$-I_1 + 3I_2 - 2\left[\frac{2}{3} I_2\right] = 0$$

$$I_1 = \left[3 - \frac{4}{3}\right] I_2 = \frac{5}{3} I_2$$

$$I_2 = \frac{3I_1}{5}$$ —— (4)

(4) $\rightarrow$ (1)

$$9I_1 - \cancel{5}\left(\frac{3I_1}{\cancel{5}}\right) = 6$$

$6I_1 = 6$ $\boxed{I_1 = 1A}$ $\boxed{I_2 = \frac{3}{5}A}$ $I_3 = \frac{2}{\cancel{3}}\left(\frac{\cancel{3}}{5}\right)$ $\therefore \boxed{I_3 = \frac{2}{5}}$

$I_{4\Omega} = I = 1A$ Ans

$I_{5\Omega} = I_1 - I_2 = 1 - \frac{3}{5} = \frac{2}{5}A$ Ans

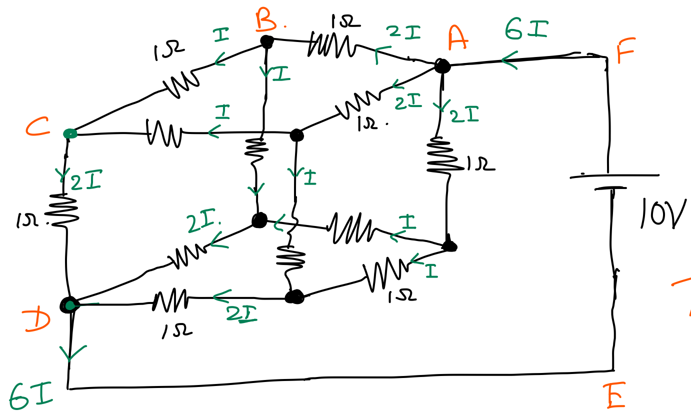
$I_{10\Omega} = I_2 - I_3 = \frac{3}{5} - \frac{2}{5} = \frac{1}{5}A$ Ans

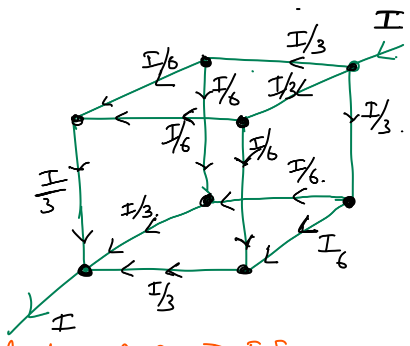
$I_{5\Omega} = I_3 = \frac{2}{5}A$ Ans

2019 Q (4)

A battery of 10V and negligible Internal resistance is connected across the diagonally opposite corners of a cubical network consisting 12 resistances of 1Ω each. Use Kirchhoff's law to determine
(1) equivalent resistance of the N/W.
(2) Total Current in the N/W.

Sol





Taking loop – ABCDEF

$-10 + 1(2I) + 1(I) + 1(2I) = 0$

$10 = 5I$

$I = 2A$

$$R = \frac{V}{I} = \frac{10}{6I} = \frac{10}{6[2]} = \frac{10}{12}\ \Omega$$

COLOUR CODE

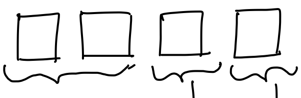
- To find Resistance Value.
- Carbon resistance.

(1) Method-1

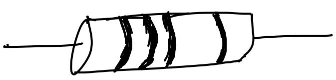
- BBROY of Great Britain has Very Good Wife.

	B	B	R	O	Y	G	B	V	G	W
Colour →	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Numb →	0	1	2	3	4	5	6	7	8	9

Tolerance.
Gold – ±5%
Silver – ±10%
No Colour – ±20%



Example

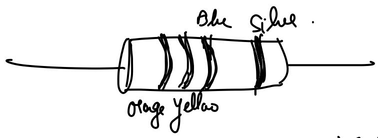


Red, Red, Red and Silver. → Sol $= 22 \times 10^2 \pm 10\%\ \Omega$.

Q $R = 34\,M\Omega$. Tell the Colour Code with 10% tolerance.

Sol $34 \times 10^{6}\,\Omega$.

Orange . yellow . Blue .



$\rightarrow$ OYBS. Ans

Q Get the Colour Code of $79\,K\Omega$ with 5% tolerance.

Sol $79 \times 10^{3}\,\Omega \pm 5\%$.

Violet White Orange . Gold .

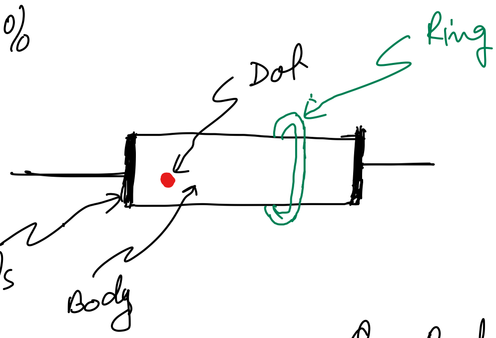
$\rightsquigarrow$ VWOG Ans

Q Grey O W S. What is the Resistance Value?

Sol Grey – 8
Orange – 3.
White – 9
Silver – ±10%

$\Rightarrow 83 \times 10^{9} \pm 10\%$ Ans

Method 2

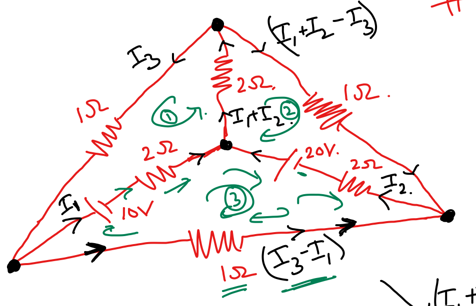


$\underbrace{\boxed{\text{Body}}\ \boxed{\text{END}}}_{\text{Number}}$ $\underbrace{\boxed{\text{DOT}}}_{\text{Power of } 10}$ $\underbrace{\boxed{\text{Ring}}}_{\text{Tolerance}}$

Q Body – Green.
End – yellow.
Dot – Red.
Ring – Gold

Sol $54 \times 10^{2} \pm 5\%$
Ans

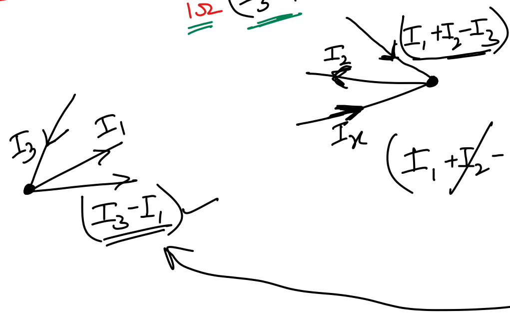
Find the Current through the Voltage Sources 10V and 20V.



$$+1I_3 + 10 + 2I_1 + 2(I_1+I_2) = 0 \quad — ①$$

$$1(I_1 + I_2 - I_3) + 2I_2 - 20 + 2(I_1+I_2) = 0 \quad — ②$$

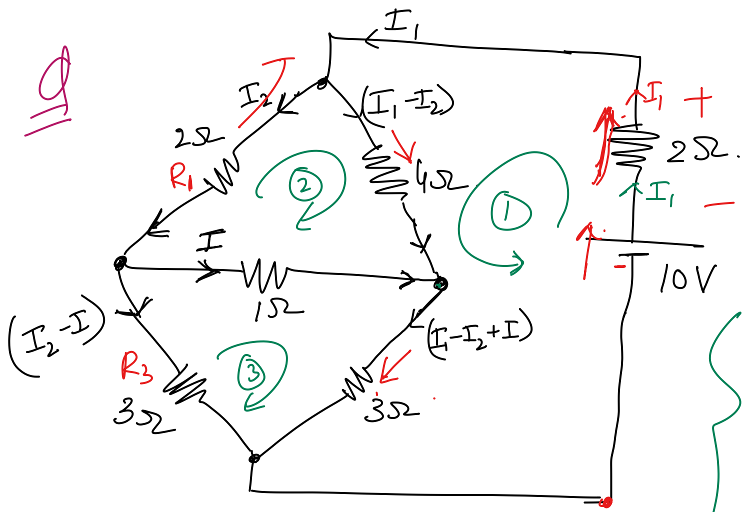
$$+20 - 2I_2 - 1(I_3 - I_1) + 10 + 2I_1 = 0 \quad — ③$$



$$(I_1 + \cancel{I_2} - I_3) + I_x = \cancel{I_2}.$$

$$I_x = (I_3 - I_1) \checkmark$$

Q



H.W

$$\boxed{\begin{matrix} R_1 = 2\Omega & : & R_4 = 3\Omega \\ R_2 = 6\Omega & & R_3 = 1\Omega \end{matrix}} \rightarrow \text{Find } I.$$

Find I.

$$-10 + 2I_1 + 4(I_1 - I_2) + 3(I_1 - I_2 + I) = 0. \quad — ①$$

$$4(I_1 - I_2) - I\times 1 - 2I_2 = 0 \quad — ②$$

$$I + 3(I_1 - I_2 + I) - 3(I_2 - I) = 0 \quad — ③$$

0.0

NOTE : $I = 0$ only when the Circuit is balanced.

$$\boxed{R_1 R_4 = R_2 R_3}$$

Resistance Related to Temp :-

$$\boxed{R = R_0[1 + \alpha \Delta t]} \qquad R \propto \rho. \qquad \boxed{\rho = \rho_0[1 + \alpha \Delta t]}$$

$R \rightarrow$ Required Resistance.

$R_0 \rightarrow$ Resistance at 0°C. (273°K)

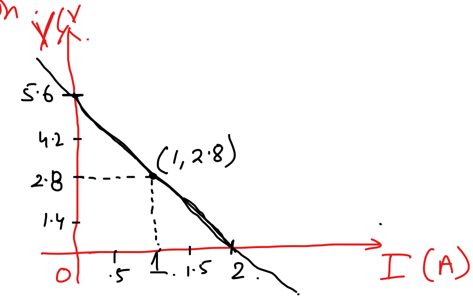
$\alpha \rightarrow$ Temperature Co-efficient.

$\Delta t \rightarrow$ Change in temp.

$$\boxed{\alpha = \frac{R - R_0}{R_0 \Delta t}} \qquad \frac{\cancel{\Omega}}{\cancel{\Omega}\ °C}$$

Unit $/°C$ = per degree Celsius

Q 4 Cells of identical emf ε, internal resistance r, are connected in series to a Variable resistance R. The graph is shown.

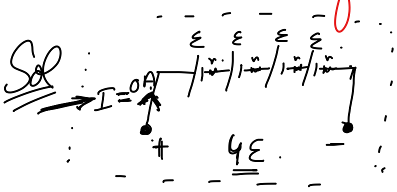


① What is the emf in each cell used?

② For what Current from the cell, does max power dissipation occur?

③ Calculate the internal resistance of each cell.

Sol



→ For $I = 0$ we get $V = 5.6\,V$ from graph.

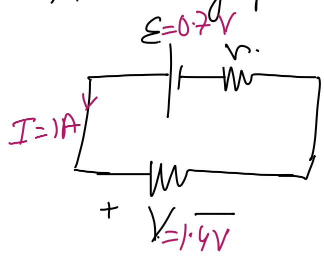
$$4\varepsilon = 5.6$$

$$\varepsilon = \frac{\cancel{5.6}}{\cancel{4}} = 1.4\,V$$ Ans

From the graph $I = 1A$: $V = 2.8V$ ⟶ This is the Contribution of 4 Cells.

$\therefore$ For one cell $= \frac{2.8}{4} = 0.7V$

Current is same $= 1A$: as the cells are Connected in series.

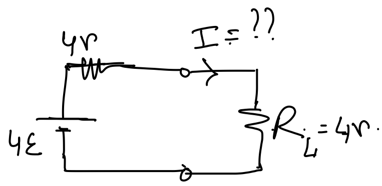


$$V = \varepsilon + Ir$$

$$1.4 = 0.7 + Ir$$

$$r = \frac{1.4 - 0.7}{I}$$

$$r = 1.4 - 0.7 = 0.7\,\Omega$$

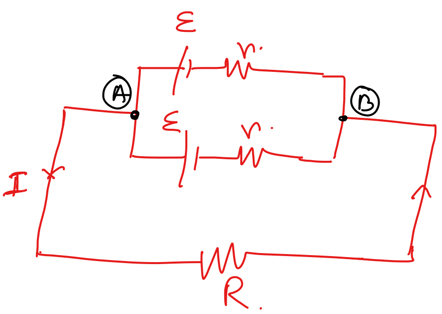


For max Power transfer $r = R_L = 4r$.

$$I = \frac{[4\varepsilon]}{4r + 4r}$$

$$= \frac{4 \times 1.4}{8r} = \frac{\cancel{4} \times \cancel{1.4}^{2}}{\cancel{8}_{2} \times \cancel{0.7}} = 1A$$ Ans

Q



Q. What Value of R, max Power will be obtained. What is this Power?

Sol Branch AB has parallel Connectivity.

$\therefore$, cells are Connected in parallel. when the Voltage has a combination of two cells to be ε_{eq}.

Total resistance in the circuit $R_{eq} = r // r + R$

$$= \frac{r \times r}{r + r} + R = \frac{r}{2} + R = \frac{r + 2R}{2}$$

$$\therefore \text{ Current } I = \frac{V}{R} = \frac{\mathcal{E}_{eq}}{\frac{r+2R}{2}} = \frac{2\mathcal{E}_{eq}}{r+2R}$$

$$\text{For Power} = P = I^2 R = \left(\frac{2\mathcal{E}_{eq}}{(r+2R)}\right)^2 \times R = \frac{4\mathcal{E}_{eq}^2 R}{(r+2R)^2}$$

$$(r+2R)^2 = r^2 + (2R)^2 + 4Rr$$
$$= r^2 + (2R)^2 - 4Rr + 4Rr + 4Rr$$
$$= \left[r^2 + (2R)^2 - 2(r)(2R)\right] + 8Rr$$
$$(r-2R)^2 + 8Rr$$

To find $\underline{P_{max}}$ we need to make the denominator zero.

$$P = \frac{4\mathcal{E}_{eq}^2 R}{(r-2R)^2 + 8Rr}$$

If $(r-2R) = 0 \rightsquigarrow P_{max} = \dfrac{4\mathcal{E}_{eq}^2 \cancel{R}}{8\cancel{R}r}$

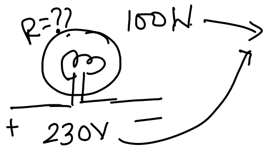
$\boxed{r = 2R}$

$\boxed{R = \frac{r}{2}} \rightarrow$ Cond. for max Power Transfer.

$$\boxed{P_{max} = \frac{\mathcal{E}_{eq}^2}{2r}}$$

Q An electric bulb is marked 100 W, 230 V. If the supply voltage drops to 115 V, what is the heat and light energy produced by the bulb in 20 minute. Calculate the current flowing through it.

Sol



→ Rated Value. $P = \frac{V^2}{R}$

$$R = \frac{V^2}{P} = \frac{230 \times 230}{100}$$

$$R = 529\ \Omega$$

$V' = 115\text{V}$

$t = 20$ minute
$= 20 \times 60 = 1200$ seconds.

$$H = P \cdot t$$

$$H = \frac{(V')^2}{R} \cdot t = \frac{115 \times 115}{529} \times 1200 = 30\ \text{KJ}$$

Ans

$P = VI = \frac{V^2}{R} = I^2R$

To find I.

$$V = IR$$
$$115 = I \times 529$$
$$I = \frac{115}{529} = 0.217\,\text{A}$$

Ans

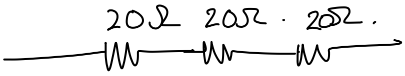
Q The max power rating of a 20 Ω resistance is 2 KW. Would you connect this resistance directly across a 300 V d.c source. Explain.

Sol: It is given that 2000 W Power can be tolerated by a given resistance of 20 Ω.

If we apply 300V let's find Power. $P = \frac{V^2}{R} = \frac{300 \times \cancel{300}^{15}}{2\cancel{0}}$

$= 4500\ W$.

NO, resistance will burn out. supplied power (4500W) is much more that the resistance can tolerate (2000W).

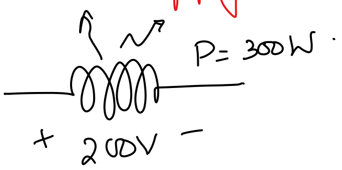


$P = \frac{300 \times \cancel{300}^{5}}{6\cancel{0}}$

$P = 1500W$

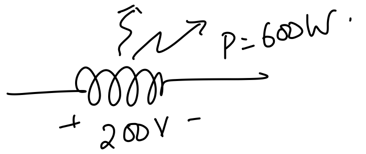
Q Two heaters are marked 200V, 300W and 200V, 600W. If the heaters are combined in series and the combination connected to a 200V dc supply, which heater will produce more heat?

Sol



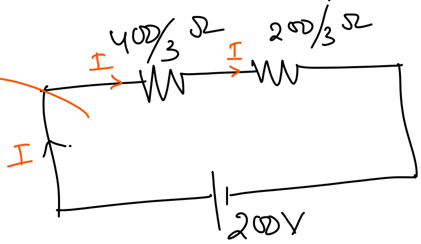
$P = \frac{V^2}{R_1} \therefore R_1 = \frac{V^2}{P}$

$R_1 = \frac{200 \times 200}{300} = \frac{400}{3}\ \Omega$



$P = \frac{V^2}{R_2} = R_2 = \frac{V^2}{P}$

$R_2 = \frac{200 \times \cancel{200}}{\cancel{600}_{3}} = \frac{200}{3}$



$I = \frac{V}{R}$

$= \frac{200}{\frac{400}{3} + \frac{200}{3}}$

$= 1A$

$H = Pt$.

$P = I^2 R$.

P_1

$P_1 = I^2 \times \frac{400}{3}$

$P_1 = \frac{400}{3} W$.

$H_1 = P_1 t$.

$= \frac{400}{3} t$

P_2.

$P_2 = I^2 \times \frac{200}{3}$.

$P_2 = \frac{200}{3}$.

$H_2 = \frac{200}{3} t$.

$\boxed{H_1 > H_2}$

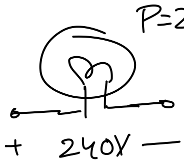
Heater 1 produces 2 times the heat as compared to

Q. The resistance of a 240V and 200W electric bulb when hot is 10 times the resistance when cold. Find its resistance at room temperature.
i) the working temp of the filament is 2000°C. Find the temp co-efficient of the filament.

Sol. Temp Co-efficient 'α'.

$\rho = \rho_0[1+\alpha\Delta T]$

$R \propto \rho$. $\quad R_1 = R_2[1+\alpha\Delta T]$



R = Resistance of cold Bulb (Room temp)

R' = Resistance of Hot bulb.

$R = \frac{R'}{10}$ $\quad \therefore \boxed{R' = 10R}$

$P = \frac{V^2}{R}$ $\quad \therefore \boxed{R' = \frac{V^2}{P}}$

$R' = \frac{240\times240}{200}$

$= 24\times12 = 288\Omega$.

$R = \frac{R'}{10}$

$= \frac{288}{10}$

$R = 28.8\Omega$ Ans

$R' = R[1+\alpha\Delta T]$.

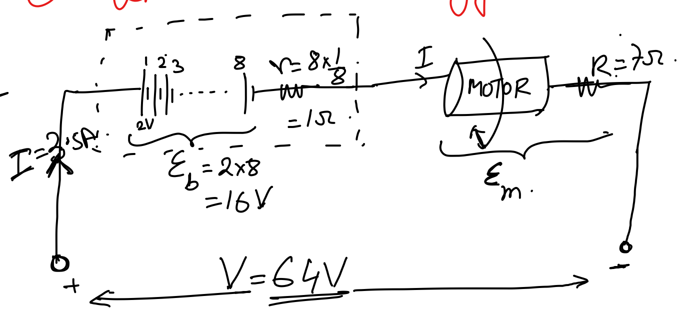
$288 = 28.8[1+\alpha[2000]]$

$10-1 = \alpha\times2000$

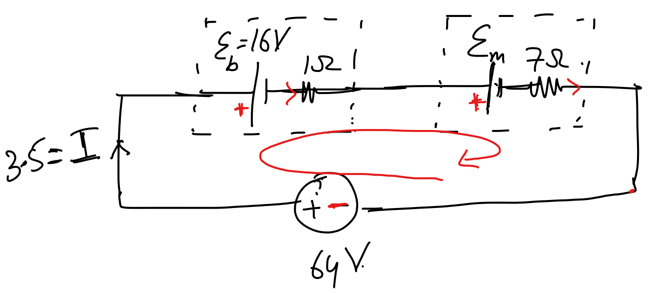
$\alpha = \frac{9}{2000} = 4.5\times10^{-3}/°C$. Ans

Q. Power from a 64V dc supply goes to charge a battery of 8 lead accumulator each of emf 2V and internal resistance $\frac{1}{8}\Omega$. The charging current also runs an electric motor placed in series with the battery. If the resistance of the winding of the motor is 7Ω and steady supply current is 3.5A. Obtain.
① Mechanical energy yielded by the motor.
② The chemical energy stored in the battery during charging in 1 hour.

Sol.



$\varepsilon_m \Rightarrow$ Back emf.



$-64 + 16 + 1I + \varepsilon_m + 7I = 0$.

$-64 + 16 + 8(3.5) + \varepsilon_m = 0$.

$\varepsilon_m = 64 - 16 - 28$

$\varepsilon_m = 20V \longrightarrow$ Motor.

$\varepsilon_b = 16V \longrightarrow$ Battery.

$t = 1\,hr = 3600$ seconds.

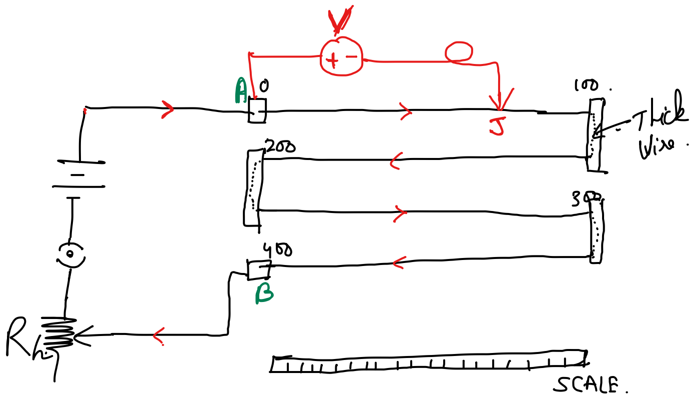
Energy in Motor = $E = P \cdot t = VI \cdot t$
$= \mathcal{E}_m \cdot I \cdot t$

$E_m = 20 \times 3.5 \times 3600$ J.
$= 252000$ J

Energy in Battery.
$E = P \cdot t = VI \cdot t$
$E = \mathcal{E}_b \cdot I \cdot t$
$E_b = 16 \times 3.5 \times 3600$ J.
$E_b = 201600$ J.

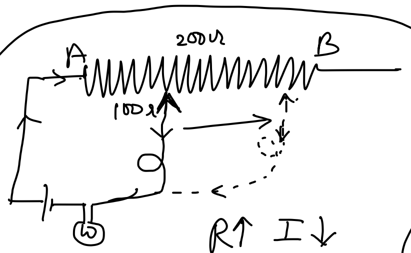
POTENTIOMETER :-

- It is a device used to measure an unknown potential difference (voltage/emf).
- This device does not draw any current from the circuit. – It is an Ideal Voltmeter.

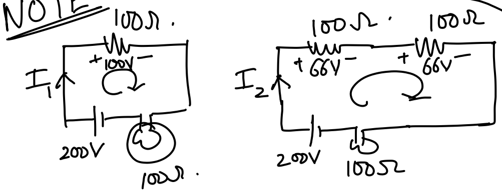


Construction :-

- We use a wire AB varying from 4m to 10m through a support. This wire has uniform crossectional area.
- We connect a battery, switch and a Rheostat (Variable resistance) with the wire, as a result current flows through the wire.
- This circuit arrangement is called "AUXILIARY" or Driver circuit.
- We have jockey which slides through the wire.
- Thick metallic strips are used at the junction of the wire. [$R \to 0$] – $R = \frac{\rho l}{A}$ → $A\uparrow$ → Thick wire. $R\downarrow$ ∴ we use thick wire



NOTE



$200 = 100I + 100I$
$I_1 = 1A$

$200 = 100I + 100I + 100I$
$I_2 = \frac{200}{300} = \frac{2}{3} = 0.66A$

PRINCIPLE :-

- The potential drop across any length of the wire is directly proportional to its length.

$V = IR$ $\qquad R = \frac{\rho l}{A}$

$V = I \frac{\rho l}{A}$

$V = \left[\frac{\rho I}{A}\right] l \Rightarrow \boxed{V = Kl}$ $\qquad K = \frac{\rho I}{A}$

$\boxed{V \propto l}$

$\boxed{K = \frac{V}{l}}$ V/m → Potential Gradient

Sensitivity of a Potentiometer.

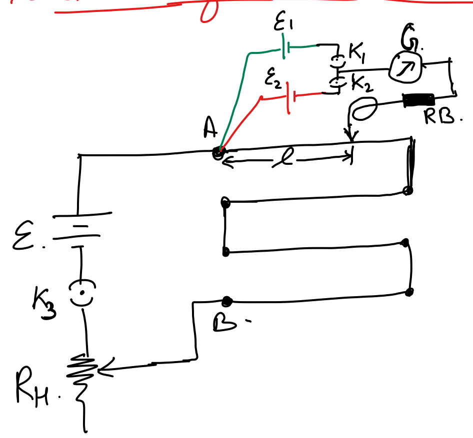
This device is sensitive if:

① It is capable of measuring very small potential.

→ ② For small change in jockey movement, the output should also change. To give a different result.

- Smaller the potential gradient, greater will be the sensitivity of the potentiometer.

APPLICATION of POTENTIOMETER: ① Comparision of emf of two cells.



- A Constant current flows through the wire with the help of driver circuit.
- ε_1 and ε_2 be the emfs of the cell.
- With same polarity connect the two cells.
- We Insert a High resistance with the Jockey. This resistance is Called "RB" "Resistance Box"

- The purpose of R.B. is to prevent large current to flow from the cell and galvanometer.
- There are two switches attached to the cells and at a time only one of them is "ON" (other OFF).
- The Jockey is moved along the wire AB till the galvanometer show no deflection.
- When K_3 and K_1 is closed and K_2 open, the jockey is moved. we find at length l_1 the deflection in GM is zero.

  ∴ we write $V = Kl \rightarrow \varepsilon_1 = Kl_1$ — for cell ε_1

- Similary, as above. $\varepsilon_2 = Kl_2$ for Cell ε_2.

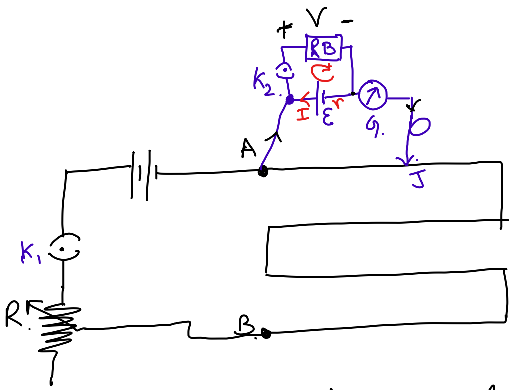
$$\boxed{\frac{\varepsilon_2}{\varepsilon_1} = \frac{l_2}{l_1}} \qquad \boxed{\varepsilon_2 = \left(\frac{l_2}{l_1}\right)\varepsilon_1}$$

② To find Internal resistance of a Cell:-

2013-17.

Q Describe briefly with the help of circuit diagram, how a potentiometer is used to determine the internal resistance of a cell.

Sol



- The Internal resistance (r) of ε needs to be Calculated.
- Close the switch K_1 with K_2 open. A Constant current flows through the potentiometer wire A to B. Move the Jockey along Wire AB untill it balances the emf ε of the Cell.
- Take the reading of length, say 'l_1'

$\therefore V = Kl \quad \therefore \varepsilon = Kl_1$ — ①

Let the internal resistance of ε be 'r' and a constant current which flows through the Cell be I.

$-\varepsilon + IR + Ir = 0$

$I = \frac{\varepsilon}{R+r} \quad : V = IR.$

$V = \left(\frac{\varepsilon}{R+r}\right)R \quad \therefore \boxed{\frac{\varepsilon}{V} = \left(\frac{R+r}{R}\right)}$ — ④

- Introduce the High resistance (RB) by switching K_2 'ON'. Move the jockey to get the balance point. Say 'l_2' and let the potential of RB to be 'V'.

$\therefore V = Kl \quad \therefore V = Kl_2$ — ②

① ÷ ② $\quad \frac{\varepsilon}{V} = \frac{l_1}{l_2}$ — ③

From ③ & ④

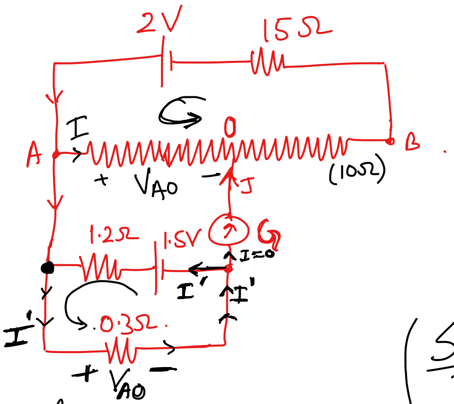
$\frac{l_1}{l_2} = \frac{R+r}{R}$

$l_1 R = l_2 R + l_2 r$

$l_2 r = l_1 R - l_2 R$

$$\boxed{r = \frac{R(l_1 - l_2)}{l_2}}$$

Q



AB is a 1 m wire of 10Ω resistance. Calculate ① potential gradient along AB. ② length AO, when galvanometer show no deflection. $I_g = 0$

Sol For Aux Circuit, Let's take a loop. (Primary ckt).

$-2 + 10I + 15I = 0 \quad \therefore I = \frac{2}{25} = 0.08\,A$

$V_{AB} = I \times R_{AB}$

$= 0.08 \times 10 = 0.8V$

P.G = K = $\frac{V}{L}$ wire $\Rightarrow K = \frac{V_{AB}}{L_{AB}} = \frac{0.8}{1} = 0.8\,V/m$ Ans

- Secondary Ckt.

$-1.5 + 1.2I' + 0.3I' = 0$

$I' = \frac{1.5}{1.5} = 1A.$

$V_{AO} = 0.3 \times 1 = 0.3V$

$PG = K = \frac{V}{L} \Rightarrow 0.8 = \frac{V_{AO}}{L_{AO}}$

$L_{AO} = \frac{0.3}{0.8} = \frac{3}{8}$ m Ans $= 0.375$ m.

$K = \frac{V}{L} \Rightarrow L\downarrow = \frac{V}{K} = \frac{V\downarrow}{0.8}$

NOTE ① What is the change when 15Ω is increased to 30Ω (Double).

$I = \frac{2}{4020} = .05A$

$V_{AB} = .05 \times 10 = 0.5V$

$K = \frac{V}{L} = \frac{0.5}{1} = 0.5 V/m$

$L = \frac{V}{K} = \frac{0.5}{0.8} = 0.625m$

① $I \downarrow$
② $V \downarrow$
③ $K \downarrow \rightarrow l$ Constant
④ $L \downarrow \rightarrow K$ Constant

shift towards left.

② What is the change when 0.3Ω is increased to 0.6Ω.

$I' = \frac{1.5}{1.8} = 0.8 A$

$V_{AO} = 0.6 \times 0.8 = 0.48V$

$L_0 = \frac{V_{AO}}{K} = \frac{0.48}{.8} = 0.6 m \rightarrow K$ Constant.

① $I' \downarrow$
② $V \uparrow$
③ $L_0 \uparrow$ shift towards Right. (K constant)

Q 2018 In a potentiometer arrangement for determining the emf of a cell, the balance point of the cell on open ckt is 350 cm. When a resistance of 9Ω is used in the external ckt of the cell, the balance point shifts to 300 cm. Find the internal resistance of the cell.

Sol $l_1 = 350cm$
$R = 9\Omega$
$l_2 = 300cm$

$r = \frac{R(l_1 - l_2)}{l_2} \Rightarrow \frac{9(350-300)}{300}$

$= \frac{9 \times 50}{300} = \frac{3}{2}\Omega = 1.5\Omega$ Ans

WHEAT STONE BRIDGE :-

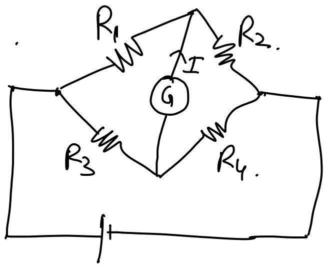
• Its the name of Physicist.

• What?? → It is an arrangement of connecting 4 Resistances.

• Why?? → To find one of the resistance when all all other 3 resistances are known.

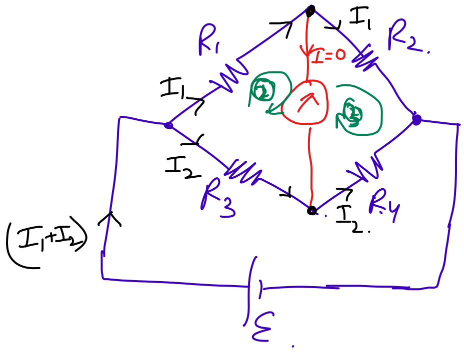
• Aim?? → To make the current through the galvanometer zero. ($I=0$)
[Balance].

• Construction → .



• Conclusion → $\boxed{R_1 R_4 = R_2 R_3}$ ⇝ Current through galvanometer is zero.

Circuit Analysis :-



$$R_1 I_1 - R_3 I_2 = 0$$

$$\frac{I_1}{I_2} = \frac{R_3}{R_1} \quad \text{——— (1)}$$

$$R_2 I_1 - R_4 I_2 = 0$$

$$\frac{I_1}{I_2} = \frac{R_4}{R_2} \quad \text{——— (2)}$$

(1) = (2)

$$\frac{R_3}{R_1} = \frac{R_4}{R_2}$$

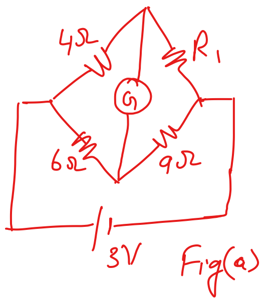
$$\boxed{R_1 R_4 = R_2 R_3}$$

• Sensitivity of Wheat stone bridge :-
It is sensitive if it shows a large deflection in the galvanometer for a small change of resistance.

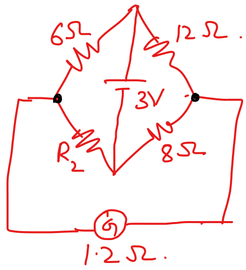
• Advantages :- (1) It is null method. ($I=0$) Therefore, the internal resistance of cell and galvanometer do not effect the ckt.

(2) Measurement of Unknown Resistance to high degree of accuracy.

Q For the figure shown, there is no deflection. Find the ratio of R_1 and R_2.



Fig(a)



Fig(b).

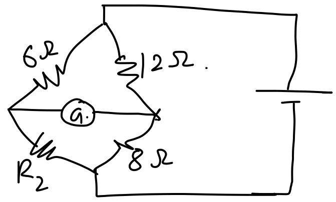
Sol Fig a

$$4 \times 9 = 6 \times R_1$$

$$R_1 = \frac{\cancel{4}^{2} \times \cancel{9}^{3}}{\cancel{6}}$$

$$R_1 = 6\Omega.$$

Fig b

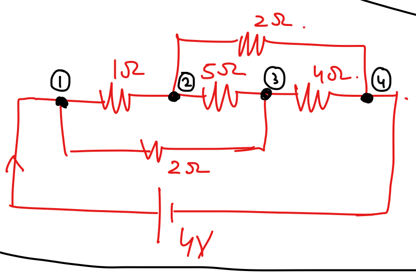


$$\cancel{12}^{3} \times R_2 = \cancel{8}^{2} \times \cancel{6}^{2}$$

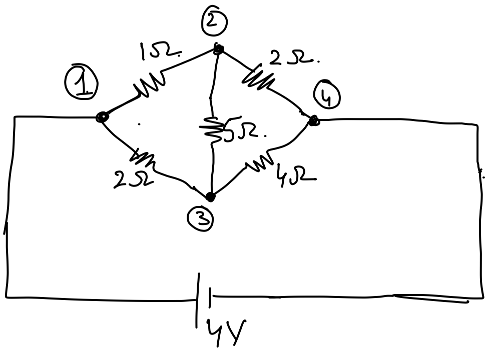
$$R_2 = 4.$$

$$\therefore \frac{R_1}{R_2} = \frac{6}{4} = \frac{3}{2} \quad \text{Ans} \quad 3:2$$

Q Find I.



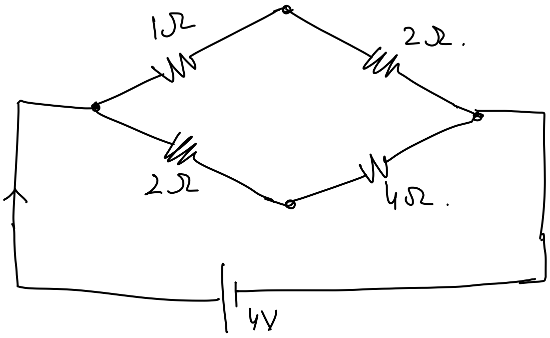
Sol



Balanced $\rightarrow 4 \times 1 = 2 \times 2$

$$4 = 4.$$

$\therefore$ No current will flow from 5Ω resistance.



$$R_{eq} = (1+2) // (2+4)$$

$$= 3 // 6 = \frac{3 \times 6}{3+6} = \frac{18}{9}$$

$$= 2\Omega.$$

$$V = IR$$

$$4 = I \times 2 \qquad \therefore I = \cancel{4}/\cancel{2} = 2A \quad \text{Ans}$$

NEET 2016, 2018.

Q A filament bulb (500W and 100V) is to be used in a 230V main supply. When a resistance R is connected in series, it works perfectly and the bulb consumes 500W. The Value of R.

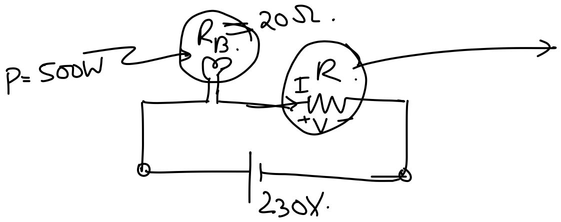
a) 230 Ω b) 46 Ω ~~c)~~ 26 Ω d) 13 Ω.

Sol

P = 500W.
V = 100V

$P = \frac{V^2}{R} \Rightarrow \cancel{500} = \frac{\cancel{100}^{20} \times \cancel{100}}{R_B}$.

$R_B = 20\Omega$



→ $V = IR$

$R = \frac{V}{I} = \frac{\cancel{130}}{\cancel{5}} = 26\Omega$

Bulb $P = \frac{V_B^2}{R}$.

$500 = \frac{V_B^2}{20}$

$V_B^2 = 10000$

$V_B = 100V$

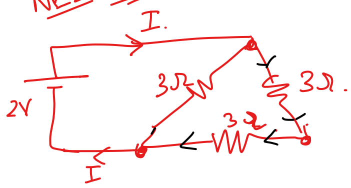
$P = VI$.

$5\cancel{00} = 1\cancel{00} \times I$

$I = 5A$ ✓

Resistance $V = 230 - 100$
$= 130V$.

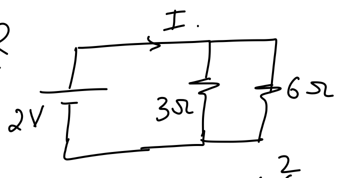
NEET-1997.



Find I.

a) 2/3 A c) 1/8 A.
~~b)~~ 1A D 2/9 A.

Sol



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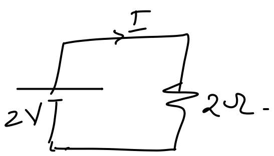
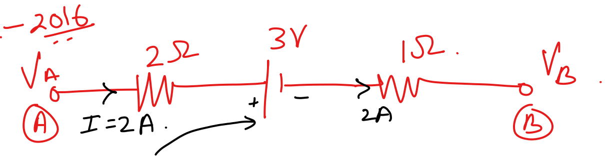


$R_{eq} = \frac{\cancel{3} \times \cancel{6}^{2}}{\cancel{9}_{3}} = 2\Omega$.

$V = IR$
$2 = I \times 2$.
$I = 1A$ Ans

NEET-2016

Q



The P.D ($V_A - V_B$) between the A & B.

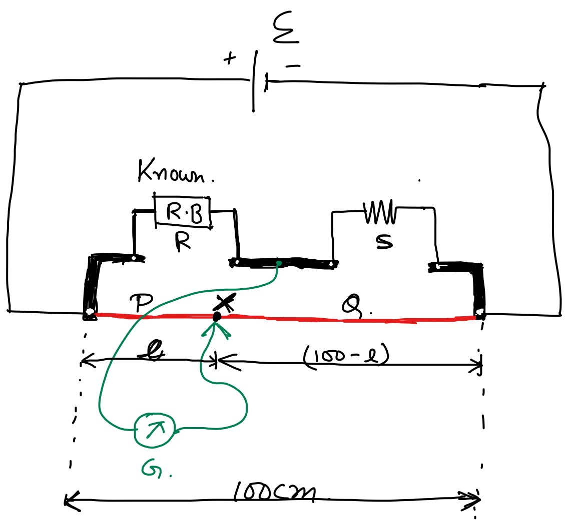
a) −3V c) +3V
b) +6V ~~d)~~ +9V.

$V_A = 2 \times 2 + 3 + 1 \times 2 + V_B$.

$V_A - V_B = 4 + 3 + 2 = 9V$

METER BRIDGE / SLIDE WIRE

- Application of Wheatstone bridge.
- To measure Unknown Resistance.
- It can measure a single Resistance Value
- Principle –
  Product of opp arm resistances are equal.



- Construction :–
  1 m or 100 cm long wire is used of Uniform crosssectional area.
  It made of "Magnanin".
- We use a Cu metal to fix the wire with the help of wooden structure.
- A Resistance Box RB is connected to act as a known resistance 'R' and the Unknown resistance 'S'.
- A Voltage E is connected across the length of wire.

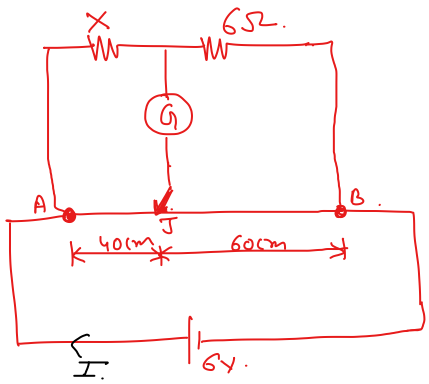
Working:
We first select the Unknown resistance 'R' from R.B. The jockey is now moved from left to right of the wire.
At some point X, we find the galvanometer reading to be zero (Balanced).

$\therefore \quad RQ = PS \longrightarrow R(100-l) = lS.$

[P = resistance of l.
Q = resistance of (100–l)

$$\boxed{S = \left(\frac{100-l}{l}\right)R}$$ ← 2019 NEET

Q In the ckt, a meter bridge is shown in balanced state. The wire has a resistance of 1Ω cm. Calculate Value of Unknown resistance X and the current drawn from the battery.



Sol

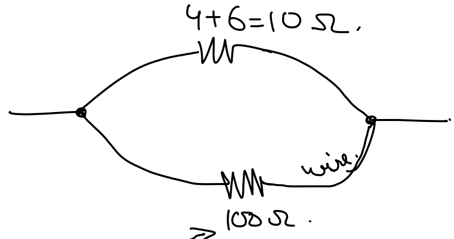
$$X(60) = 6\times(40)$$

$$X = \frac{\cancel{6}\times 4\cancel{0}}{\cancel{6}\cancel{0}} = 4\,\Omega \quad \text{Ans}$$

Correct Drawn

$$V = IR.$$

$$I = \frac{6}{R_{eq}}.$$



Wire = 1 Ω cm.

→ 1 Ω resistance in every 1 cm.

and we have 100 cm wire.

$$\therefore R_{wire} = 1 \times 100$$

$$= 100\,\Omega$$

$$R_{eq} = 10 // 100.$$

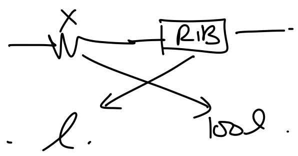
$$= \frac{10\times 10\cancel{0}}{11\cancel{0}} = \frac{100}{11}\,\Omega.$$

$$\therefore I = \frac{6\times 11}{100} = \frac{66}{100} = 0.66\,A \quad \text{Ans}$$

Q With a certain resistance in the left gap of a slide wire meter bridge, the balance point is obtained when a resistance of 10 Ω is taken out from the resistance box. On increasing the resistance from the resistance box by 12.5 Ω, the balance point shifts by 20 cm. Find the Unknown resistance.

Sol

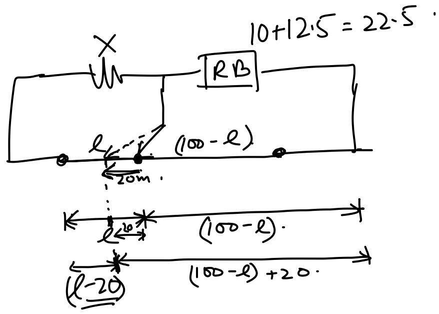
$$X(100-l) = 10\,l. \quad \text{—— (1)}$$



Resistance is increased by 12.5 Ω.

$$\therefore R = 10 + 12.5$$

$$= 22.5\,\Omega.$$



$$X(100-l+20) = 22.5(l-20).$$

$$X(120-l) = 22.5(l-20) \text{—— (2)}$$

(1) ÷ 2

$$\frac{\cancel{X}(100-l) = 10\,l.}{\cancel{X}(120-l) = 22.5(l-20)}$$

$$22.5(100-l)(l-20) = 10\,l(120-l).$$

$$2.25\left[100l - 2000 - l^2 + 20l\right] = 120l - l^2.$$

$$2.25\left[-l^2 + 120l - 2000\right] = 120l - l^2.$$

$$-2.25\,l^2 + 270\,l - 4500 = 120\,l - l^2$$

$$-1.25\,l^2 + 150\,l - 4500 = 0$$

$$l^2 - 120\,l + 3600 = 0.$$

$$l^2 - 60l - 60l + 3600 = 0$$

$$l(l-60) - 60(l-60) = 0$$

$$(l-60)(l-60) = 0$$

$$(l-60)^2 = 0$$

$l = 60, 60\,cm$

$X(100 - l) = 10 l$

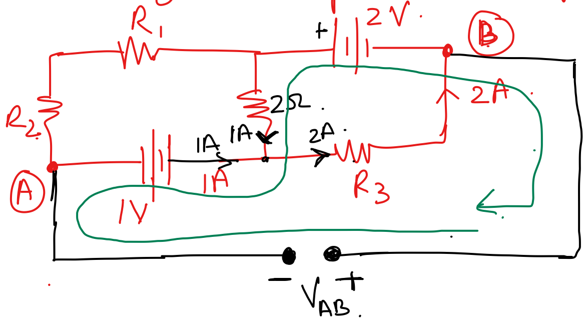
$X(100 - 60) = 10 \times 60$

$X = \frac{\cancel{70}^{5} \times \cancel{60}^{3}}{\cancel{2}\cancel{40}} = 15\,\Omega$ Ans

NEE-2011

Q For the ckt shown. if the potential at point A is zero, the potential at point B is.

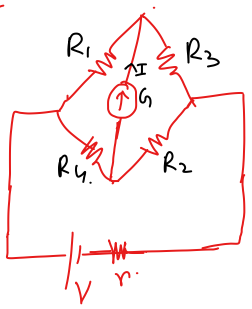
~~a)~~ +1V b) -1V c) 2V, d) -2V



Sol $+V_{AB} - 1 - 2(1) + 2 = 0$

$V_{AB} = 1 + \cancel{2} - \cancel{2} = 1V$

#

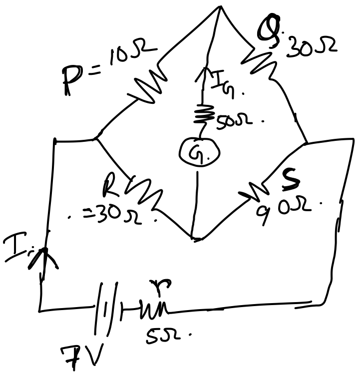


$\underline{I=0}$ If $\boxed{R_1R_2 = R_3R_4}$ → Balanced WSB.

NEET 2013.

Q Resistance of 4 arms P, Q, R & S are 10Ω, 30Ω, 30Ω and 90Ω. The emf and internal resistance of the cell are 7V and 5Ω. If the G.M resistance 50Ω the current drawn from cell.

a) 0.1 A. b) 2A c) 1A. d) 0.2A.

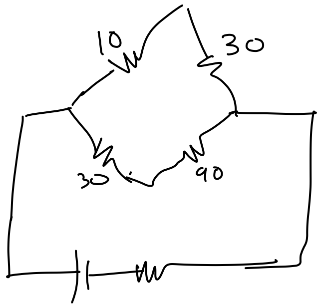


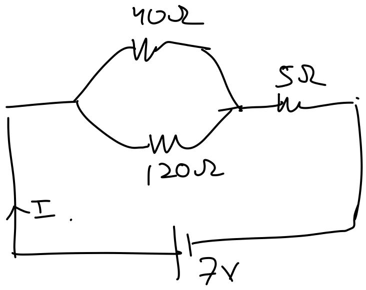
Sol

$$P \times S = Q \times R$$
$$10 \times 90 = 30 \times 30$$
$$900 = 900$$

∴ Its balanced Bridge.

$I_G = 0\,A$.





$$R_{eq} = \frac{\cancel{40}^{10} \times \cancel{120}^{3}}{\cancel{160}_{4}} = 30 + 5 = 35\,\Omega$$

$V = IR$

$7 = I \times 35 \rightsquigarrow I = \frac{7}{35} = \frac{1}{5} = 0.2\,A$ Ans