CLASS-12 SKC PHYSICS CRUSH Saleem Bhaiya

CLASS
12

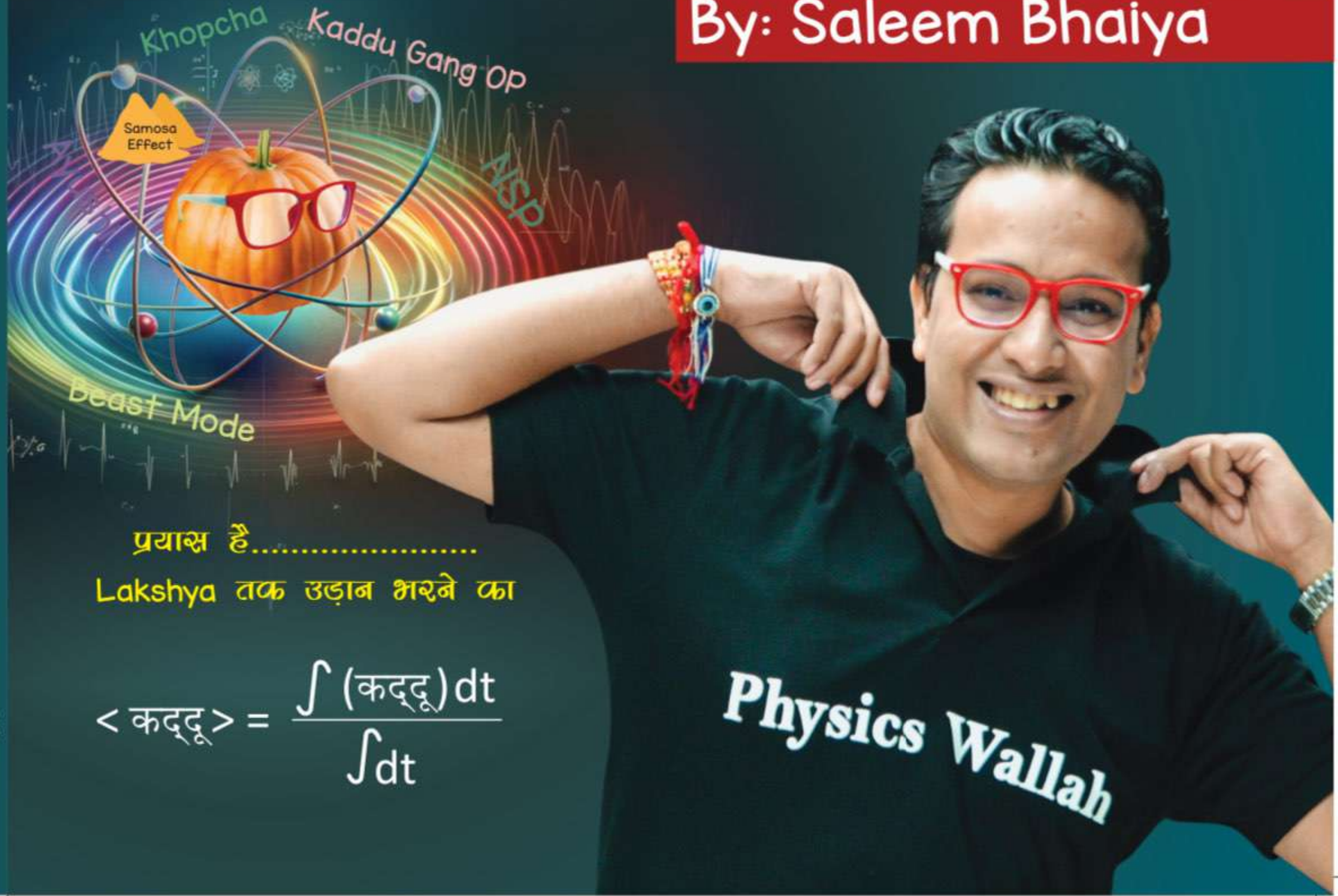
SKC

PHYSICS CRUSH

Class Notes in Handwritten Format

A beautiful journey From basic to JEE advanced via Mains/ NEET

By: Saleem Bhaiya



SKC

Saleemians Khopcha Concept

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2 Current Electricity

✦ Current (i) ⇒ Rate of flow of charge, scalar quantity

$$i = \frac{dq}{dt}$$

✦ Inst Current = $i = \frac{dq}{dt}$

✦ Average Current = $\langle i \rangle = \frac{\int i.dt}{\int dt} = \frac{\Delta q}{\Delta t}$

✦ $\langle \vec{V} \rangle$ = Average velocity = $\frac{\int v dt}{\int dt}$

$\langle \text{कददू} \rangle = \frac{\int \text{कददू}\ dt}{\int dt}$

Q. Given $i = 3t^2$

(a) Find current at t = 2 sec

Sol. $i = 3 \times 2^2 = 12$

(b) Finds average current from $t = 0 \rightarrow t = 2$

$$\langle i \rangle = \frac{\int_0^2 i dt}{\int_0^2 dt} = \frac{\int_0^2 3t^2 dt}{\int_0^2 dt} = \frac{8}{2} = 4$$

(c) $i = 3t^2$ Find the charge flow from

$t = 0 \rightarrow t = 2sec$

$$\Delta q = \int i dt = \int_0^2 3t^2 dt = 8$$

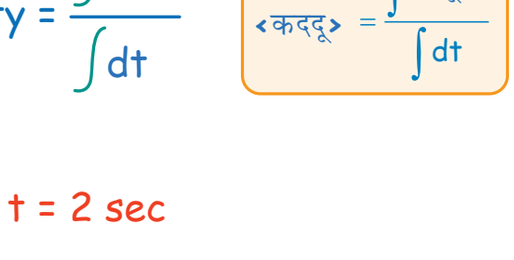
☆ $\boxed{i = \frac{dq}{dt}}$

$\int dq = \int i dt$

$\Delta q = \int i dt$ = Area

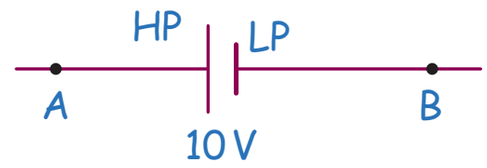
↓

charge flow

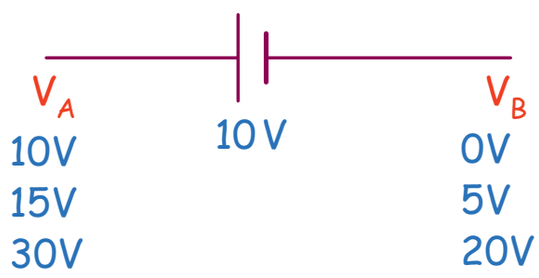


अबे सुनो Current electricity में सबसे जरूरी होता है circuit analysis तो sequence change करके saleem bhaiya के sequence में पढ़ते है from basic to advance.

☆ Ideal battery



$V_A - V_B = 10$



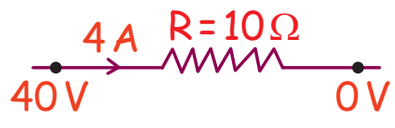
☆ Ohm's Law (derivation बाद में देखेंगे)

CE में बहुत जरूरी है V = iR लगाना सीखना let's start it.

$V_A - V_B = iR$ or $V = iR$ ↳pot. diff.

i → Resist में H.P to L.P

Q. Find current in the resistance in following cases.

(a) 

Sol. $i = \frac{40 - 0}{10} = 4$

(b) 

Sol. $i = \frac{50}{10} = 5$

(c) 

Sol. $i = \frac{50 - (-10)}{10} = \frac{60}{10} = 6$

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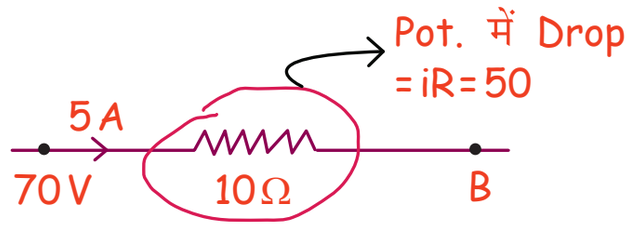
Pot. में iR का drop आ जाएगा

$$i = \frac{V}{R} = \frac{V_A - V_B}{R}$$

direction of current

⇒ HP to LP (Resistance)

(d) Find V_B.



Sol. $V_B = 70 - 50 = 20\,V$

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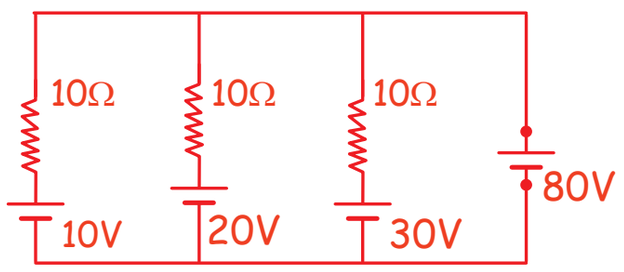
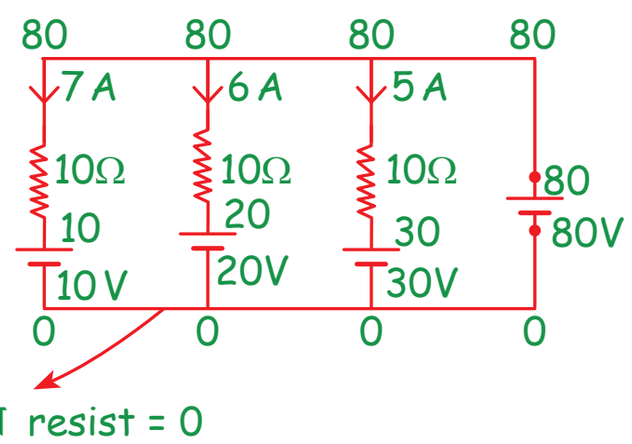
Resistance मे current H.P to L.P flow करेगा but Battery मे कैसे भी कर सकता है

Q. Find current through each resistors.

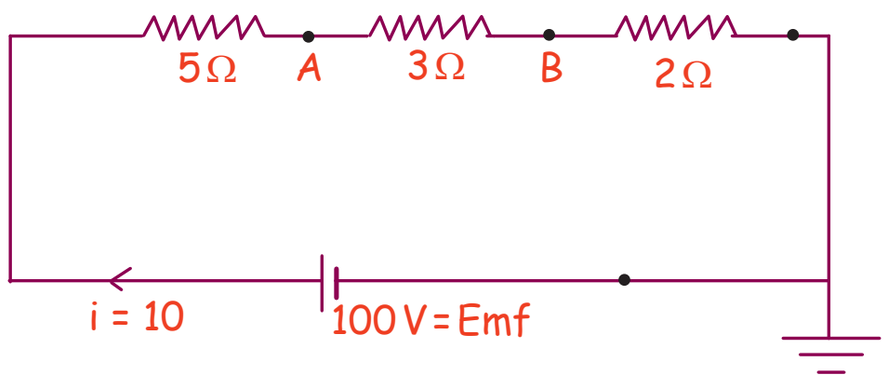


Sol.

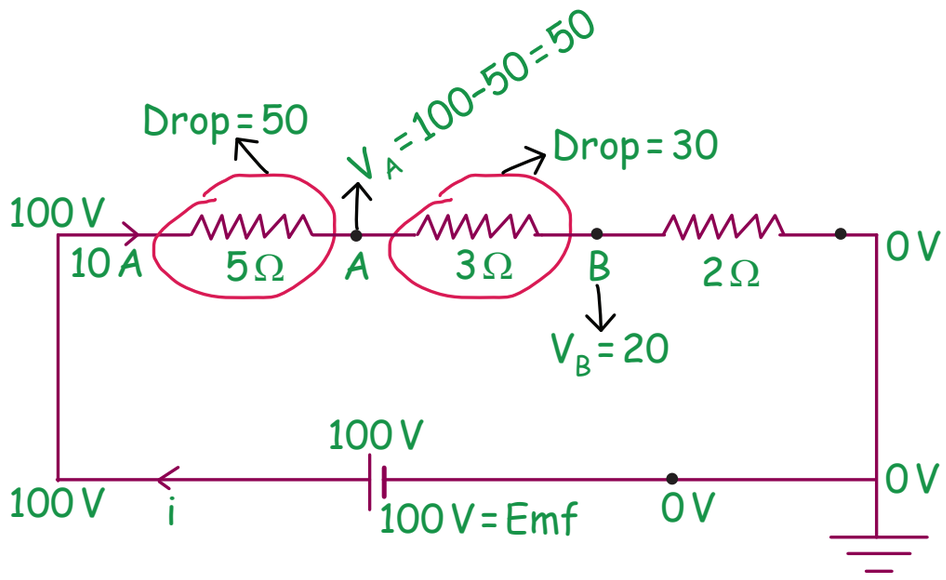


wire का resist = 0

Q. Find current and potential at A & B.



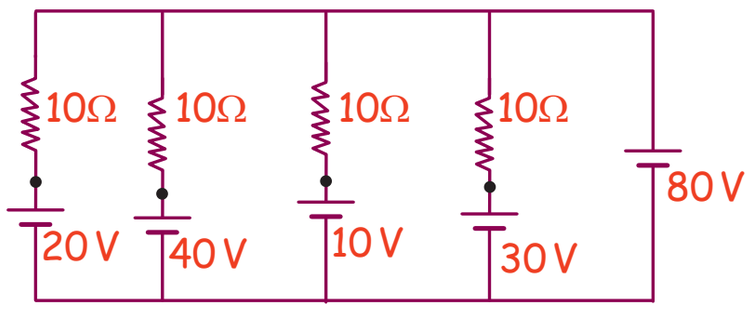
Sol.



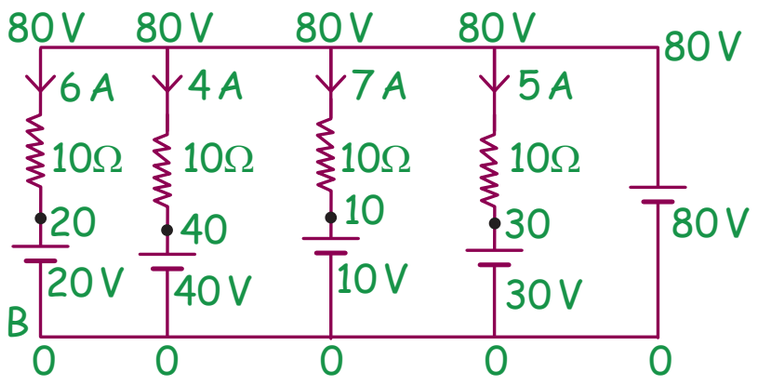
$$i = \frac{E}{R_{eq}} = \frac{100}{10} = 10A$$

$$R_{eq} = 5 + 3 + 2 = 10\Omega$$

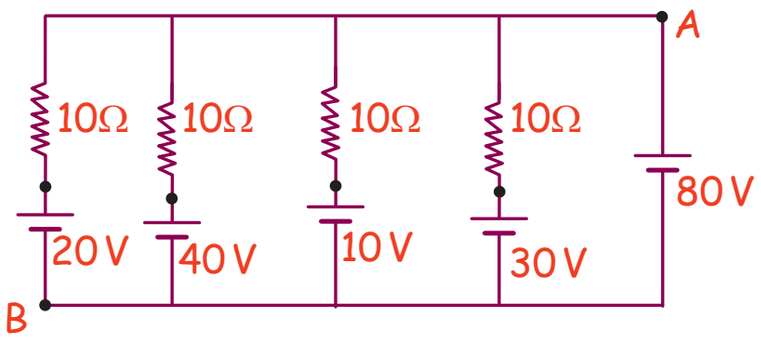
Q. Find current through each resistors (R = 10Ω each)



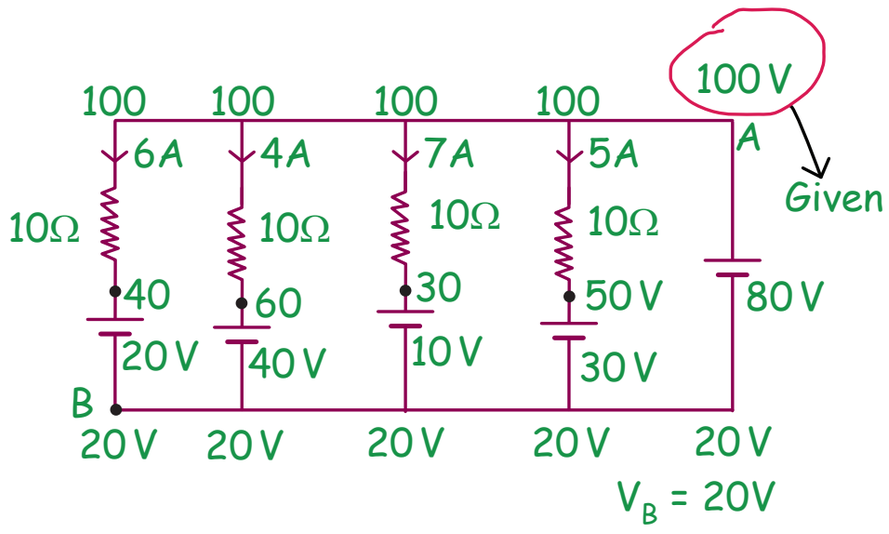
Sol.



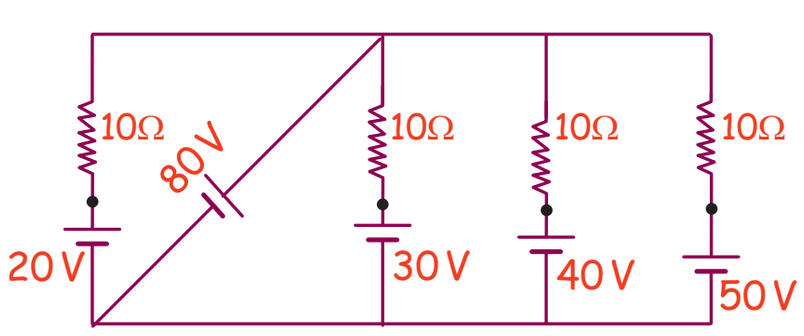
Q. If pot. at A is 100V, find V_B & Current. (R = 10Ω each)



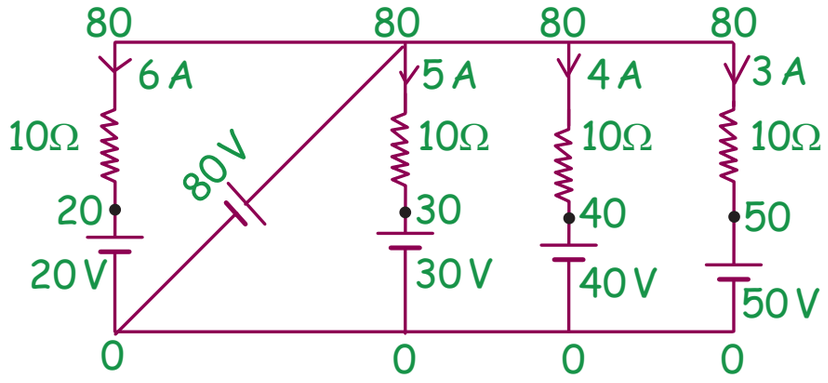
Sol.

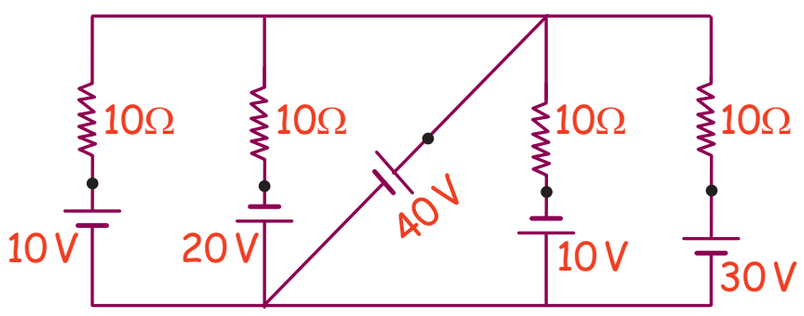


Q. Find i in each resistance

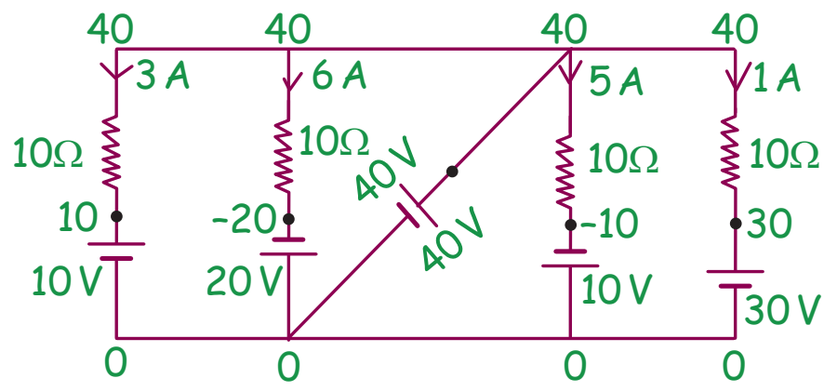


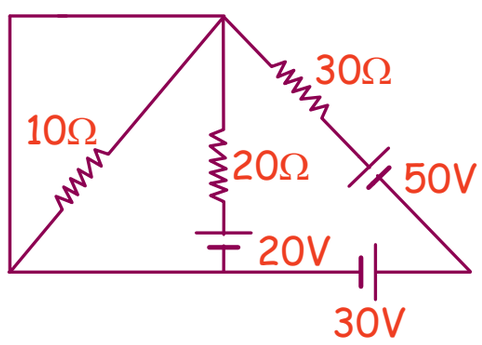
Sol.



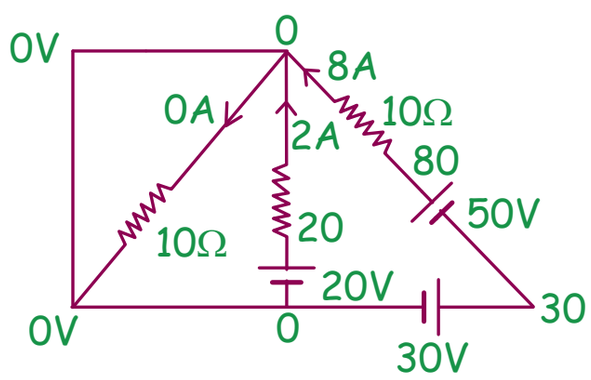


Sol.



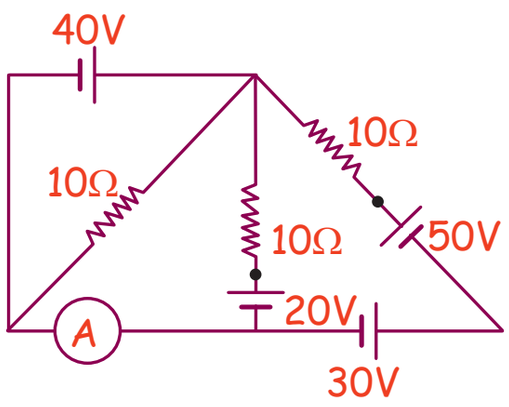


Sol.

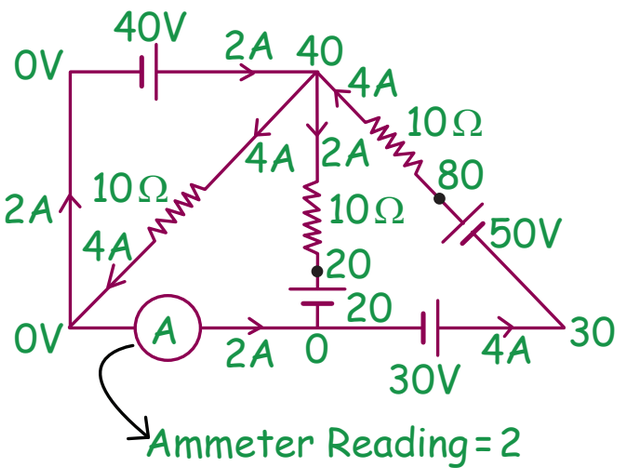


यहाँ 10 Ω short circuit हो गया

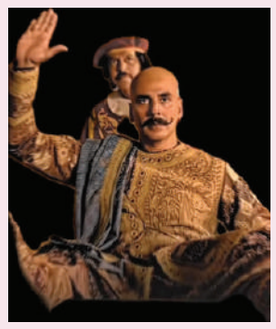
Q. What is ammeter reading?



Sol.

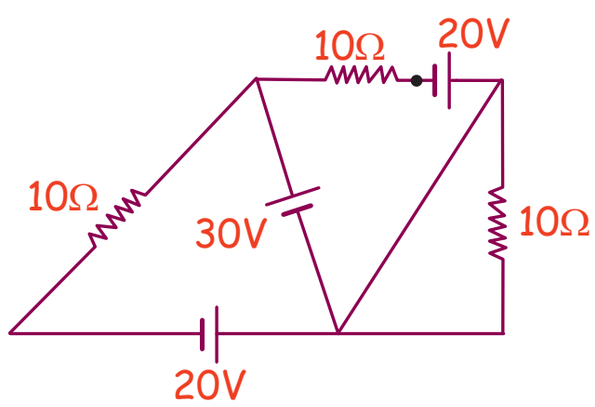


माना की no. of pages of book को कम से कम रखने का pressure है to minimise the MRP/- लेकिन circuit analysis के सवाल हम भर-भर कर practice करेंगे। (Bcz it's vry imp)

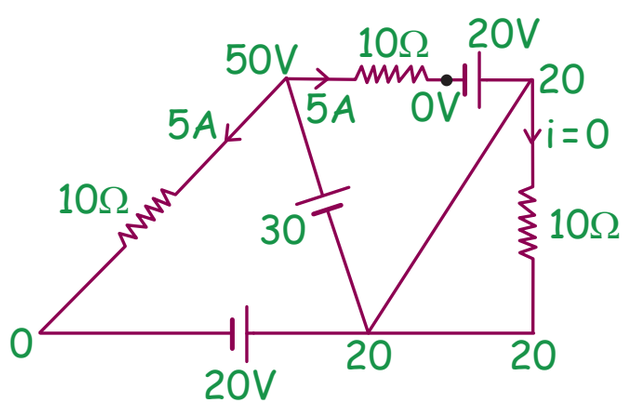


अबे ready हो ना मुझे ऐसा लग रहा है ये तुमी हो.....नीचे के left side के सारे सवाल खुद से solve करो और right side से match कराओ..... और जब सारे सवाल हो जाए मुझे insta पर confirmation दो। (ID: saleem.nitt)

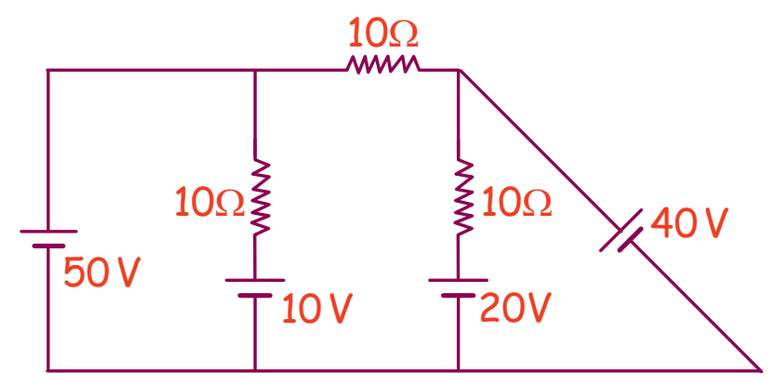
Q. Find current in each resistors.



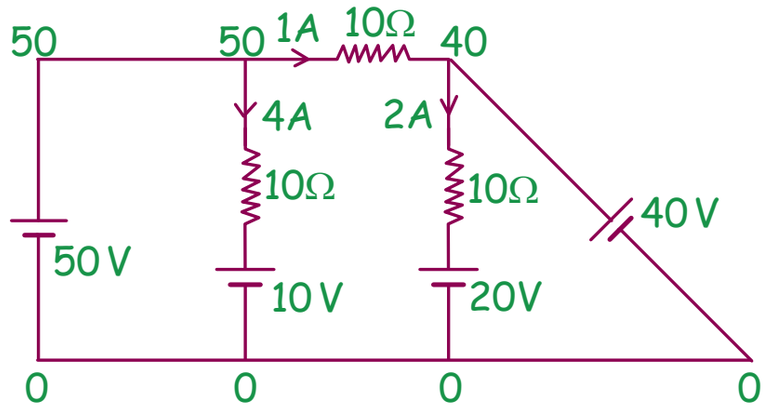
Sol.



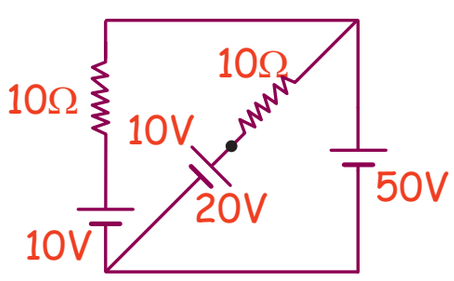
Q. Find current in each resistors.



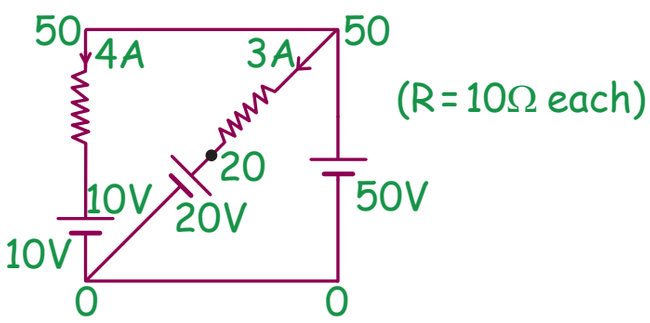
Sol.



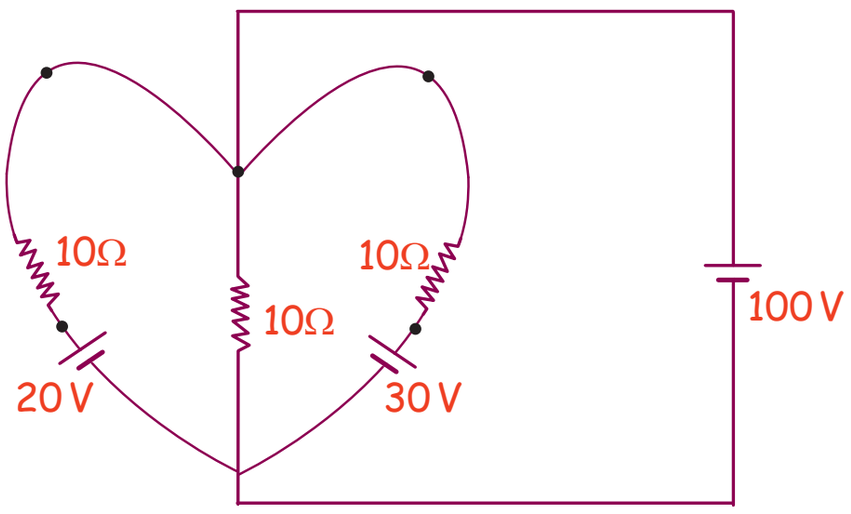
Q. Find current in each resistors.



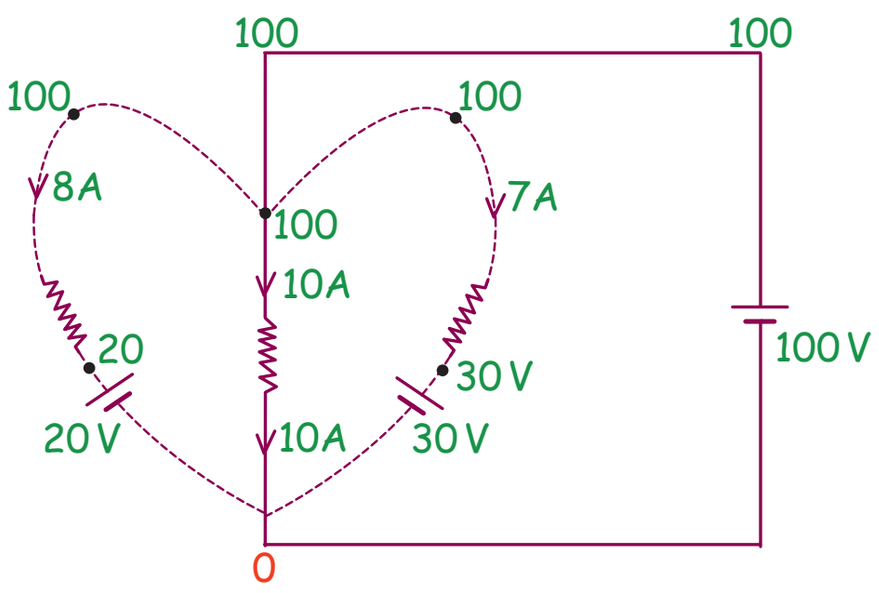
Sol.

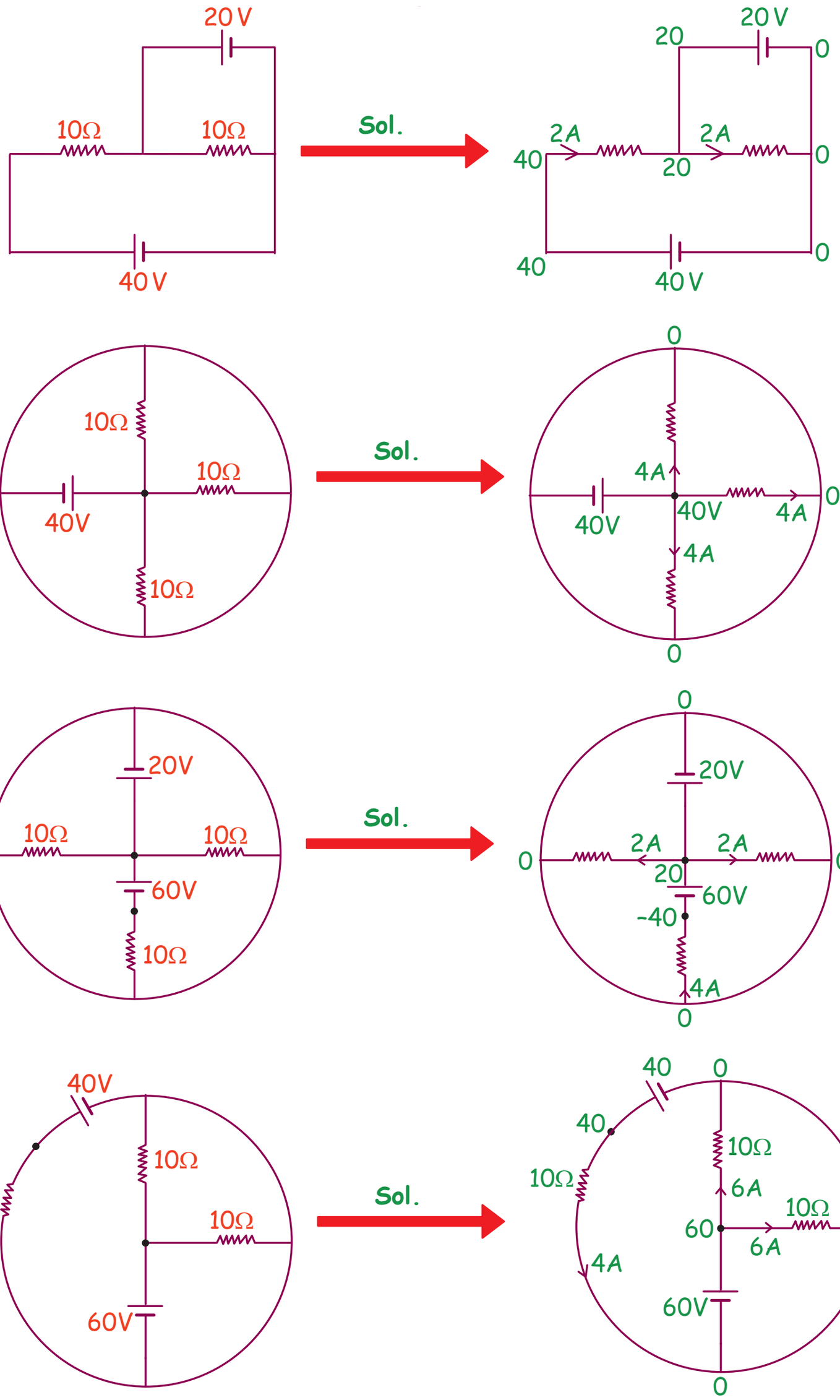


Q. Find current in each resistors.

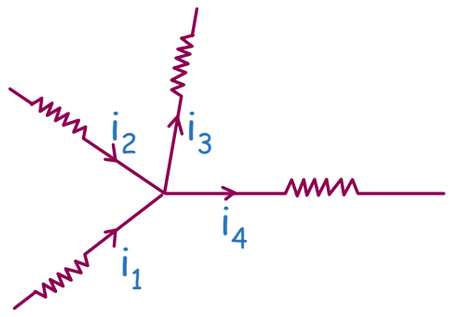


Sol.

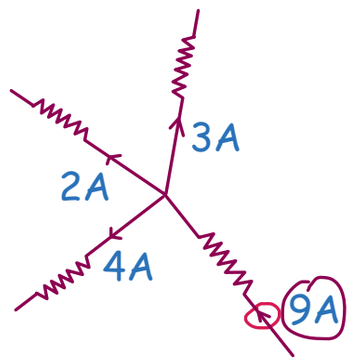



20 V
10Ω
10Ω
40 V
Sol.
20 V
20
0
2A
2A
40
20
0
40
0
40 V
10Ω
10Ω
40V
10Ω
Sol.
0
4A
40V
40V
4A
0
4A
20V
10Ω
10Ω
60V
10Ω
Sol.
0
20V
2A
2A
0
0
20
60V
-40
4A
0
40V
10Ω
10Ω
10Ω
Sol.
40
0
40
10Ω
10Ω
6A
60
10Ω
0
6A
4A
60V
0
10Ω
10Ω
40V
Sol.
40
40
1A
4A
3A
10Ω
10Ω
10Ω
40V
0
10V
10
20V
30
10V
20V

JUNCTION LAW



$i_1 + i_2 = i_3 + i_4$ (आने वाली = जाने वाली)



OR

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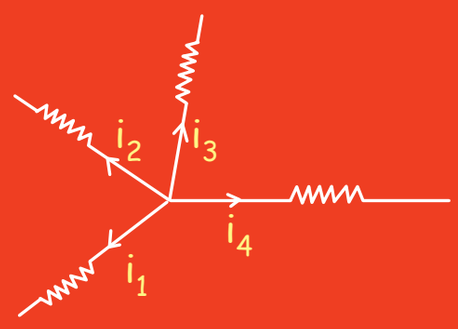
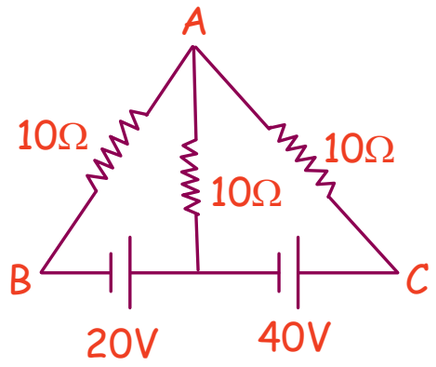
किसी भी junction से total जाने वाला current का sum = 0

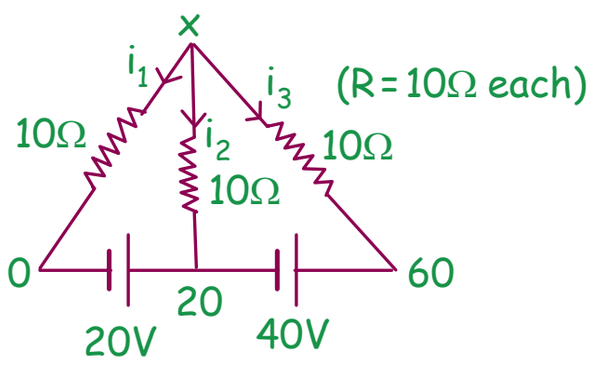


$i_1 + i_2 + i_3 + i_4 = 0$ (junction law)

Q. Find current in each resistance



Sol.



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अगर B का potential 0 मानू तो C का potential will be 60 volt लेकिन हम A का potential नही बता सकते, हम फँस गए.....

जहाँ फँस जाओ वहाँ EX को याद करो.....

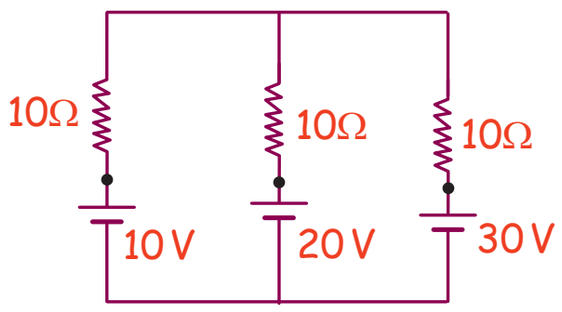
अबे emotional मत हो I mean जहाँ फँसे वहाँ potential X मान लो और junction law लगादो

$i_1 + i_2 + i_3 = 0$

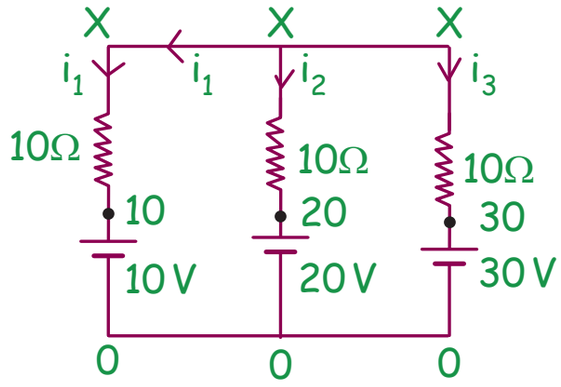
$$\frac{x-0}{10} + \frac{x-20}{10} + \frac{x-60}{10} = 0$$

$$x = \boxed{\frac{80}{3}}$$

Q. Find current through each resistance.



Sol.



$i_1 + i_2 + i_3 = 0$

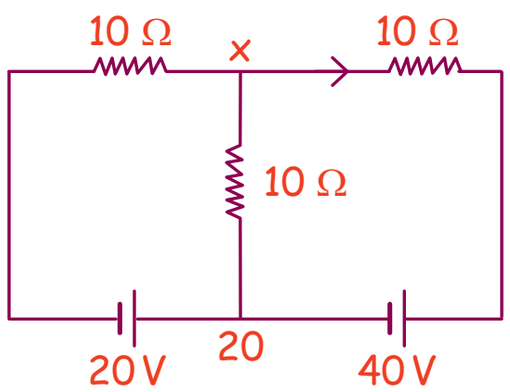
$$\frac{x-10}{10} + \frac{x-20}{10} + \frac{x-30}{10} = 0$$

$x = 20$

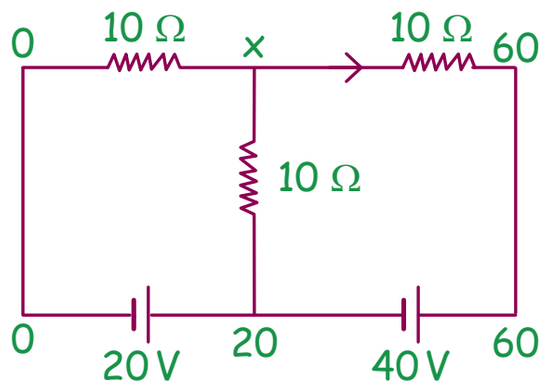
now we can find current though any wire

$i_1 = \frac{x-10}{10} = 1A$ and $i_2 = \frac{x-20}{10} = 0$

Q. Find current through each resistors.



Sol.

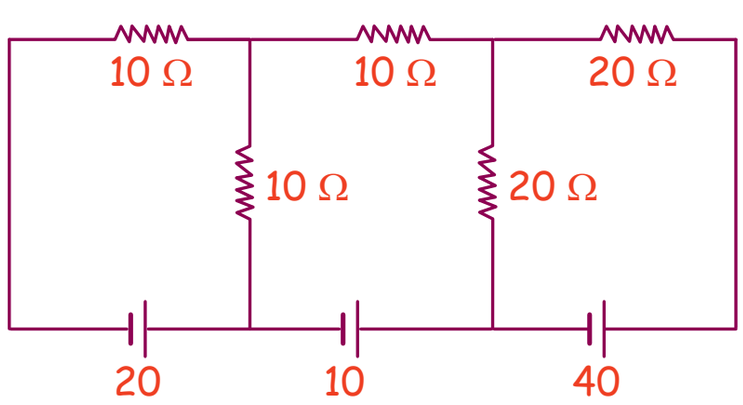


$$i_1 + i_2 + i_3 = 0$$

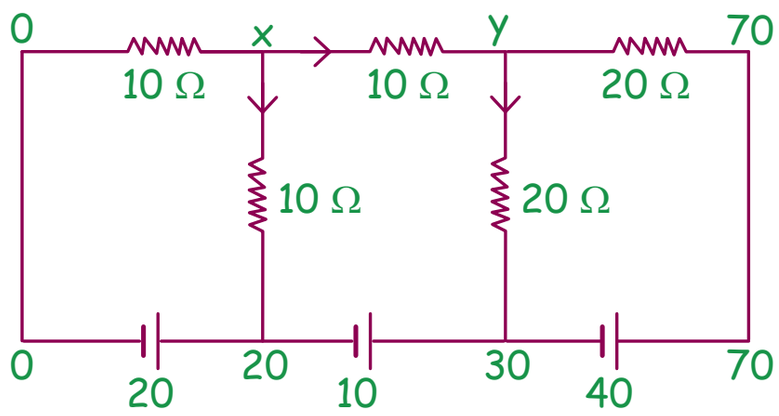
$$\frac{x-0}{10} + \frac{x-20}{10} + \frac{x-60}{10}$$

$$x = \frac{80}{3}$$

Q. Find potential (x).



Sol.



$$\frac{x-0}{10} + \frac{x-20}{10} + \frac{x-y}{10} = 0$$

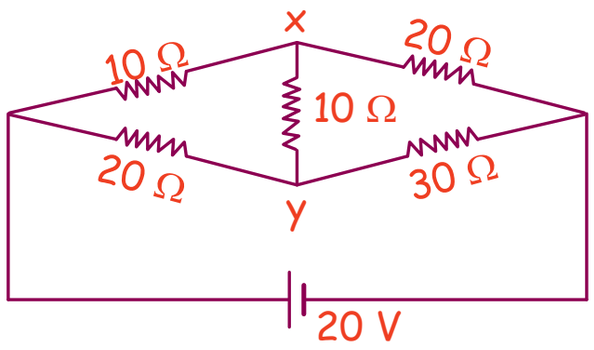
$$3x - y = 20 \qquad \ldots(1)$$

$$\frac{y-x}{10} + \frac{y-30}{20} + \frac{y-70}{20} = 0$$

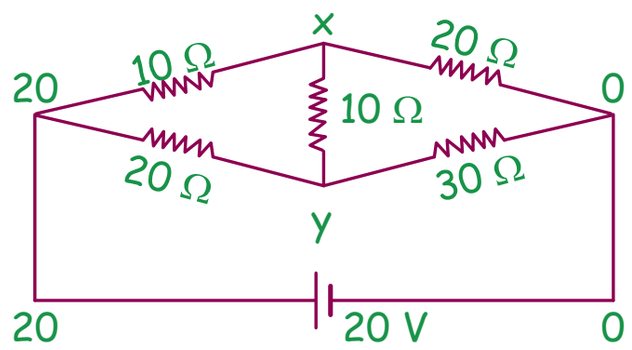
$$4y - 2x = 100 \qquad \ldots(2)$$

Now we solve both eqn. and get answer

Q. Find $V_x - V_y = ?$



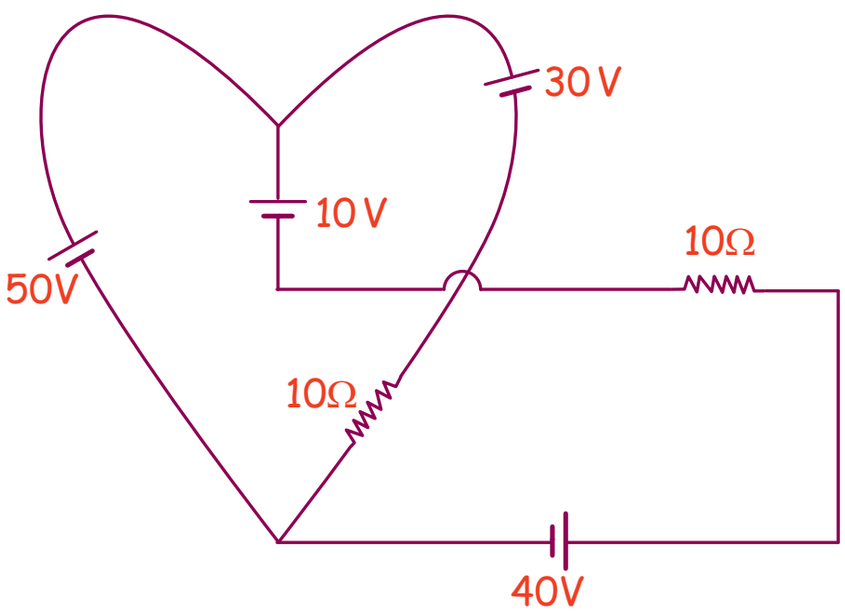
Sol.



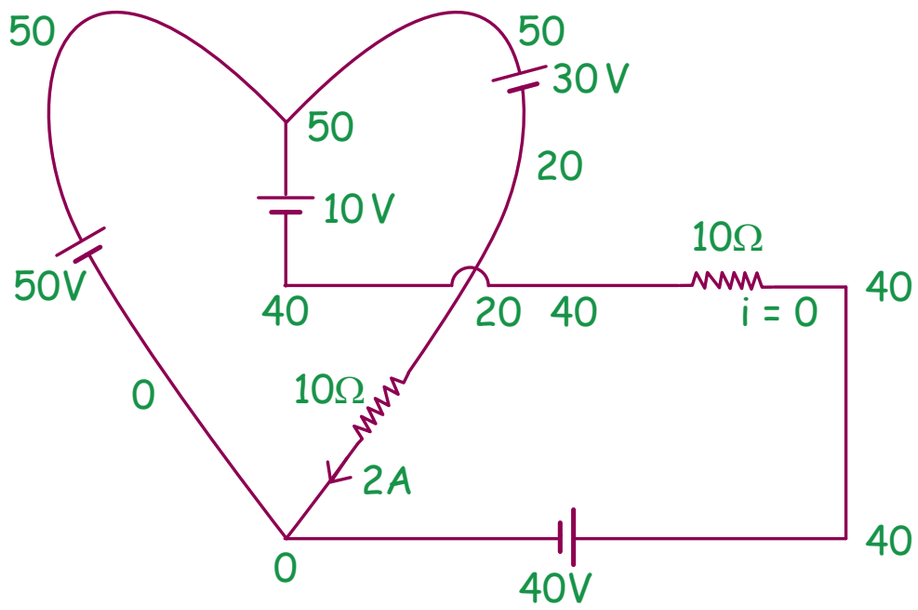
$$\frac{x-20}{10} + \frac{x-y}{10} + \frac{x-0}{20} = 0$$

$$\frac{y-20}{20} + \frac{y-x}{10} + \frac{y-0}{30} = 0$$

Q. Find current through each resistors.

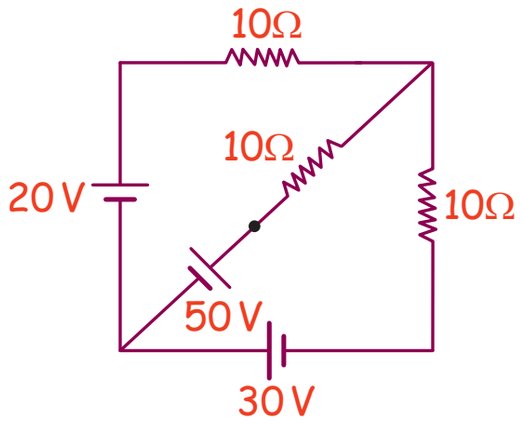


Sol.

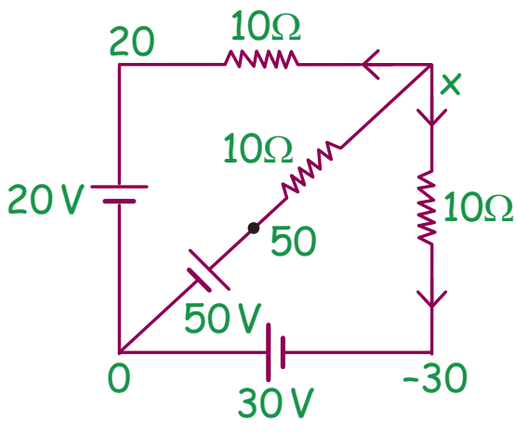


$v = iR$

Q. Find current through each resistors.



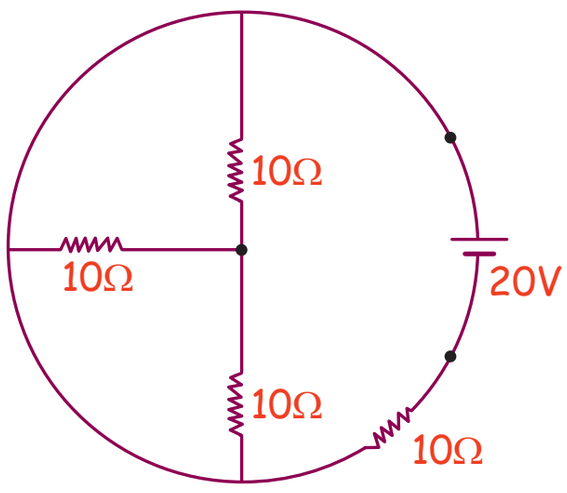
Sol.



$$\frac{x-20}{10}+\frac{x-50}{10}+\frac{x+30}{10}=0$$

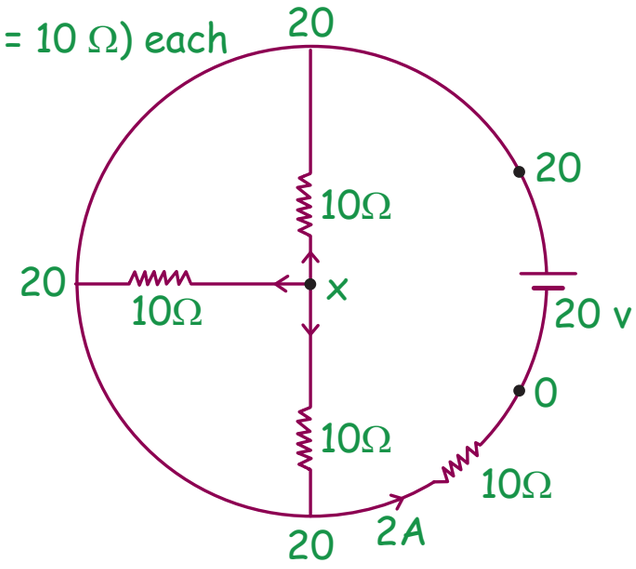
$$x=\frac{40}{3}$$

Q. Find current through each resistors.



Sol.

(R = 10 Ω) each

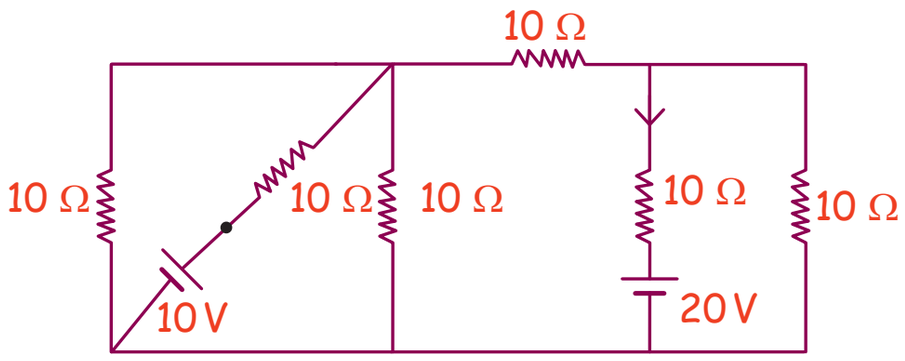


$$\frac{x-20}{10}+\frac{x-20}{10}+\frac{x-20}{10}=0$$

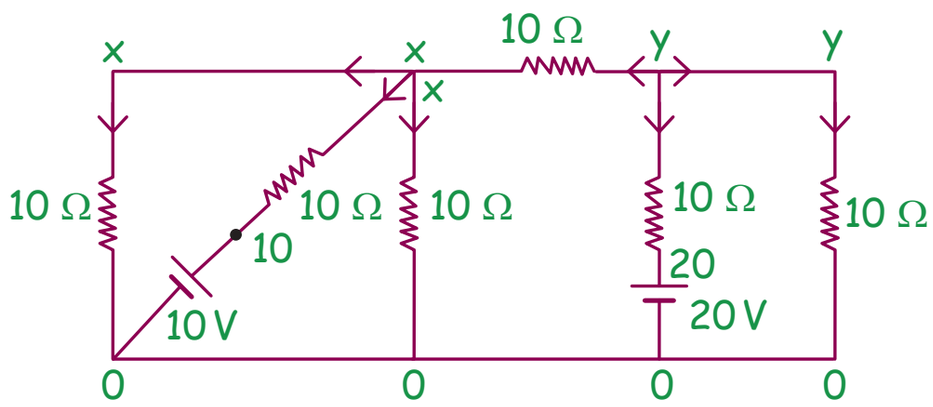
$x = 20$

$i_1 = i_2 = i_3 = 0$

Q. Find current through each resistors.



Sol.



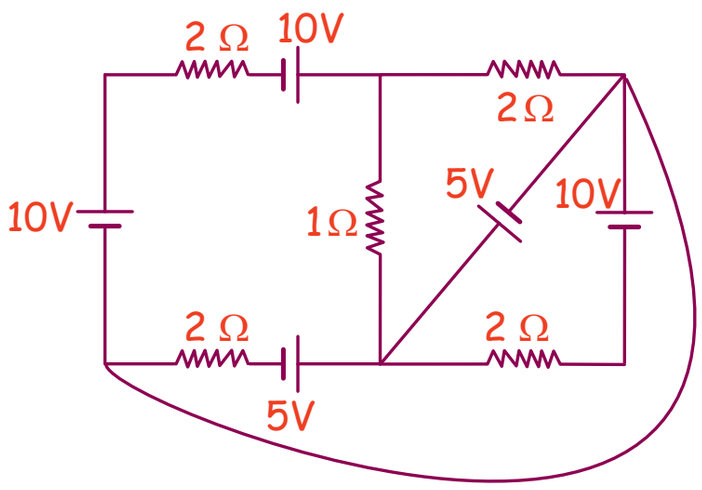
Apply junction law at x

$$\frac{x-0}{10}+\frac{x-10}{10}+\frac{x-0}{10}+\frac{x-y}{10}=0$$

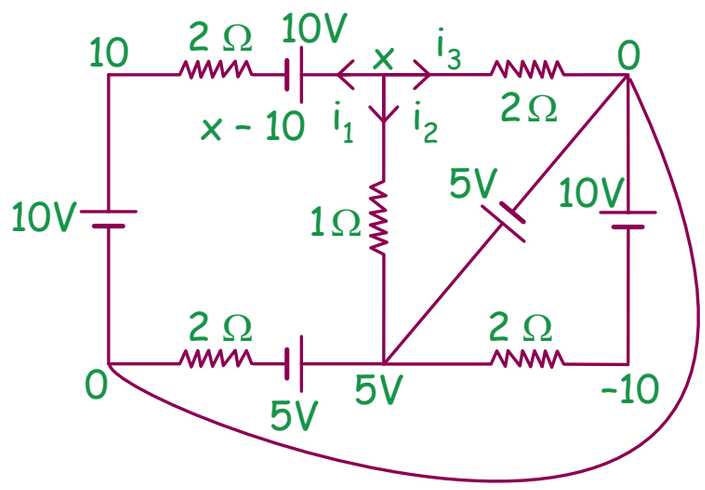
Apply junction law at y

$$\frac{y-x}{10}+\frac{y-20}{10}+\frac{y-0}{10}=0$$

Q. Find current through each resistors.



Sol.



$$\frac{x-10-10}{2}+\frac{x-5}{1}+\frac{x-0}{2}=0$$

$$x-20+2x-10+x=0$$

$$4x=30=7.5$$

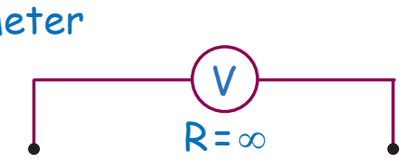
$$i_2=\frac{x-5}{1}=7.5-5=2.5$$

#SKC
ideal Amm का Resistance
⇒ Zero
ideal Voltmeter का Resistance ⇒ ∞
क्योंकी हम चहते है (A) (V) का
इस्तेमाल करते वक्त circuit
ना बदले

✦ Ideal Ammeter

Reading = i

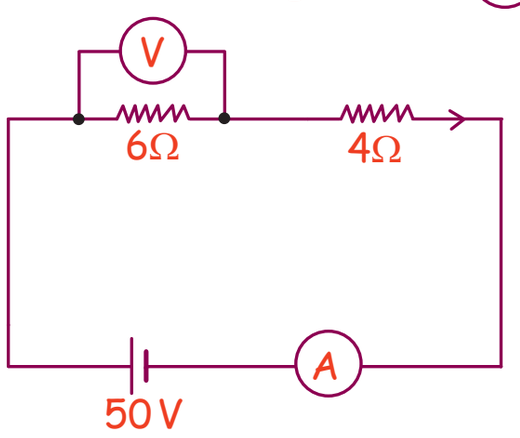
✦ Ideal Voltmeter



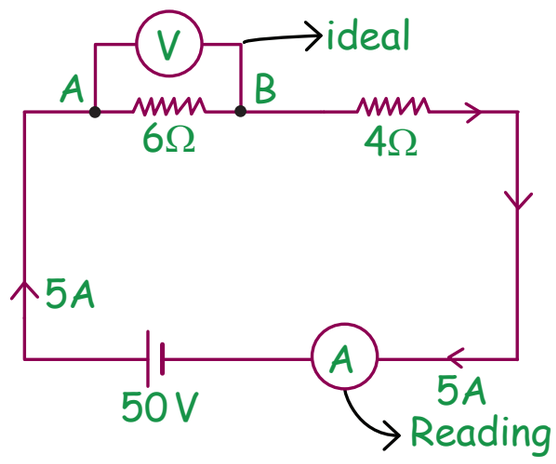
A B

$|V_A - V_B|$ = Reading

Q. Find the reading of ideal (V) & (A)

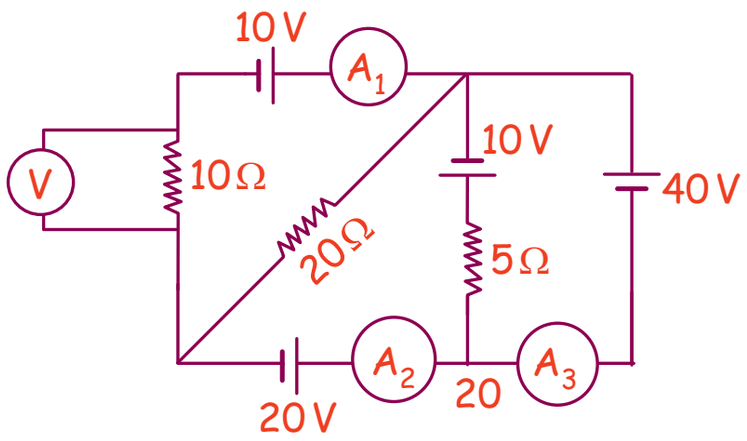


Sol.

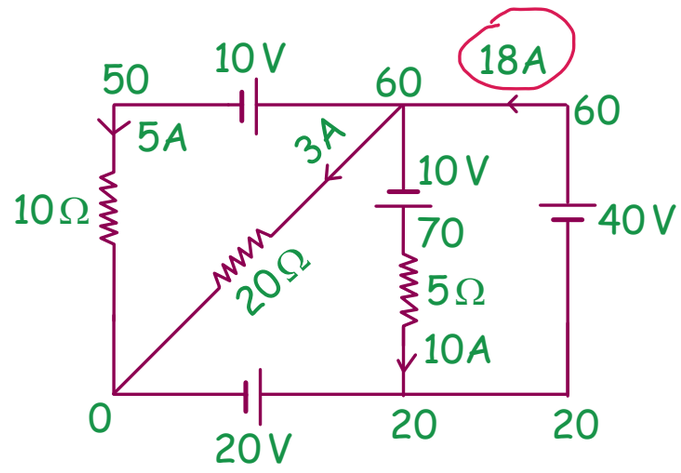


$V_A - V_B = 5 \times 6$ = Reading of voltmeter

Q. Find the reading of (A) & (V)



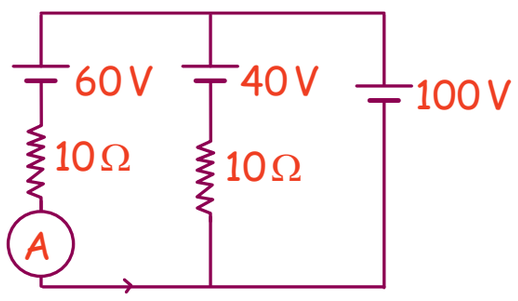
Sol.



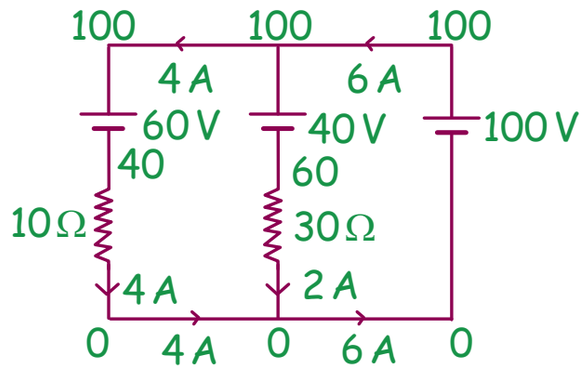
Ammeter की reading मतलब उससे कितना current pass कर रहा है अगर ammeter ideal है तो उसे wire मान लो। voltmeter की reading मतलब जिन दो point के बीच उसे connect किया है उनके बीच potential difference अगर voltmeter ideal है तो उसके through i = 0

Reading of A_1 = 5A
Reading of A_2 = 8A
Reading of A_3 = 18A
Reading of Voltmeter = 50

Q. Find the reading of (A)

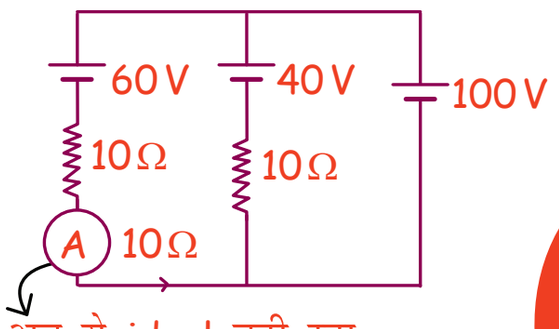


Sol.



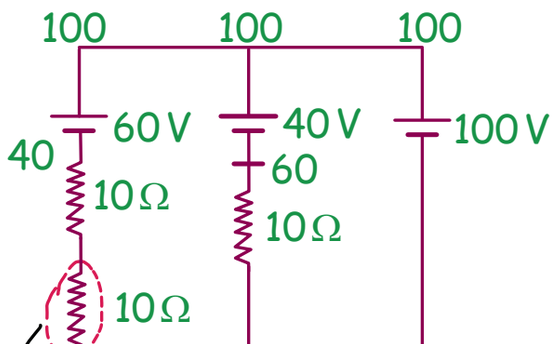
Ans. 4 A

Q. What is the reading of non-ideal ammeter?



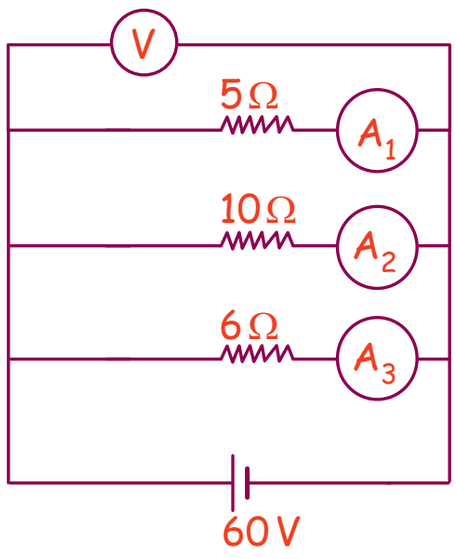
अब ये ideal नही रहा

Sol.

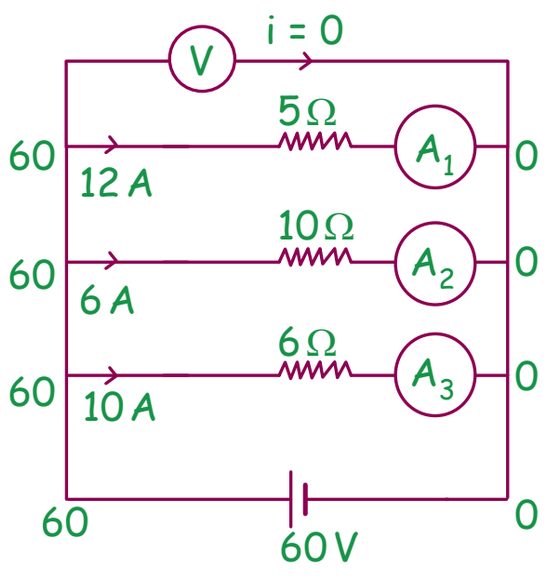


Ammeter wallah resistance

Q. What will be the readings?



Sol.

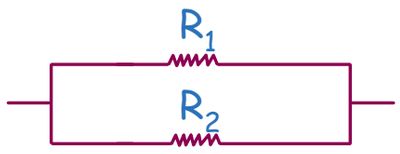


All are ideal:
Reading of (V) = 60V
Reading of (A_1) = 12A
Reading of (A_2) = 6A
Reading of (A_3) = 10A

If two resistance R_1 and R_2 are in parallel then

Parallel

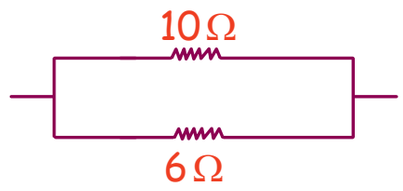
$\Delta V \rightarrow$ same



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

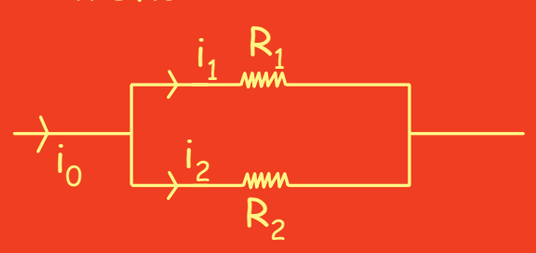
$$R_{eq} = \frac{R_1 R_2}{R_2 + R_2} = \frac{\text{multiply}}{\text{sum}}$$

Q.



Sol. $R_{eq} = \frac{10 \times 6}{10 + 6} = \frac{60}{16}$

#SKC



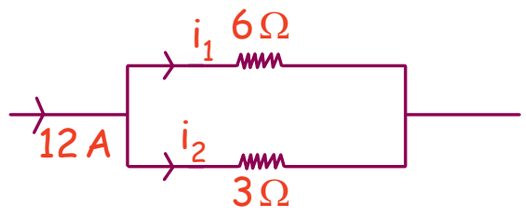
IMP

i_1 = सामने वाला 'R' × total current/total R

$$i_1 = \frac{R_2}{R_1 + R_2} \times i_0$$

$$i_2 = \frac{R_1}{R_1 + R_2} \times i_0$$

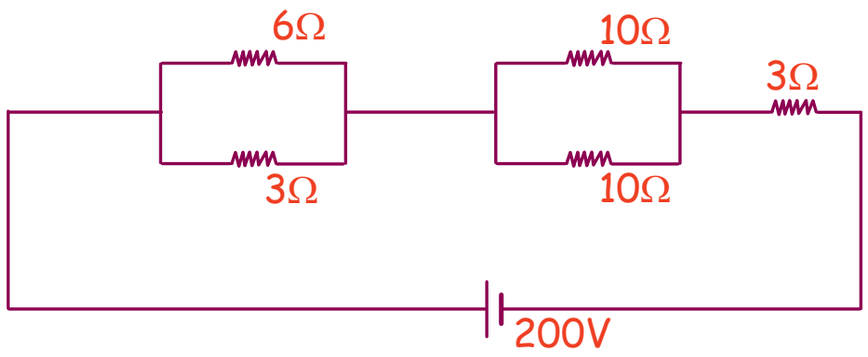
Q. Find i_1 and i_2



$$i_1 = \frac{3}{9} \times 12 = 4A$$

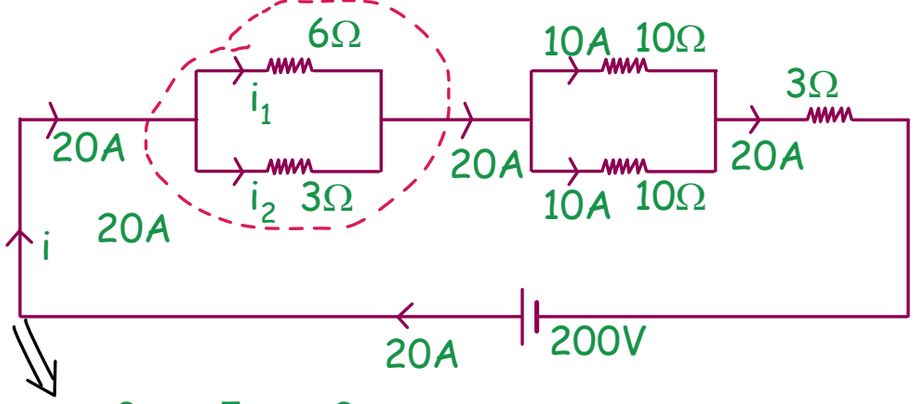
$$i_2 = \frac{6}{9} \times 12 = 8A$$

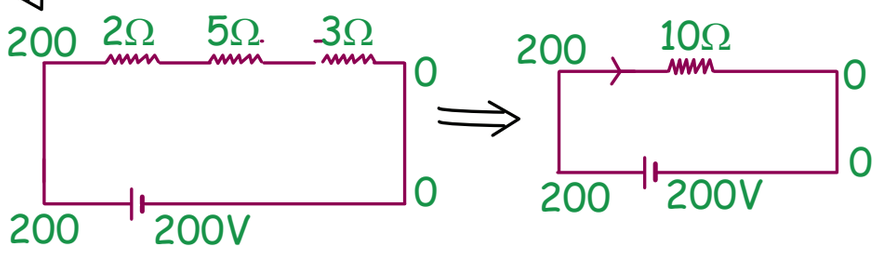
Q. Find current through each resistors.



Sol.

$R_{eq} = \frac{\text{Multiply}}{\text{sum}}$





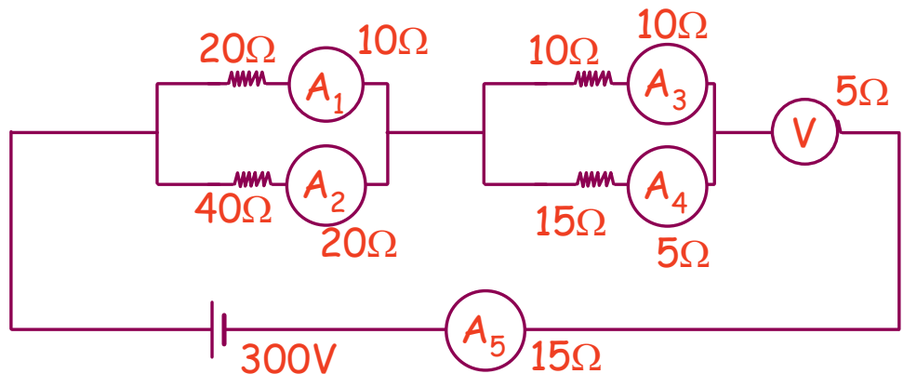
$R_{eq} = 2 + 5 + 3 = 10\Omega$

$$i = \frac{V}{R_{eq}} = \frac{200}{10} = 20A$$

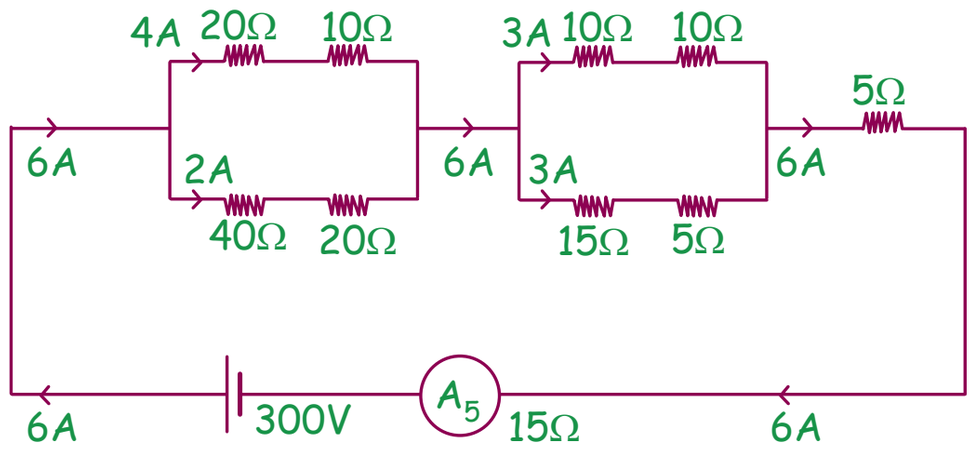
$$i_1 = \frac{3}{3 + 6} \times 20 = \frac{20}{3}$$

$$i_2 = \frac{6}{3 + 6} \times 20 = \frac{120}{9}$$

SSSQ. What will be reading of A_1 A_2 A_3 A_4 and V?

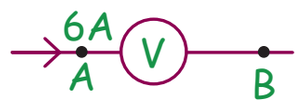


Sol.



Reading of $A_1 \rightarrow 4A$

Reading of $A_2 \rightarrow 2A$



Reading of $A_3 \rightarrow 3A$

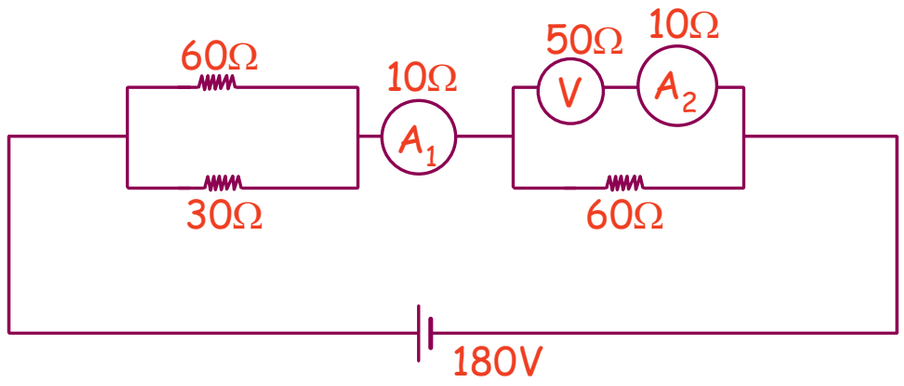
Reading of $A_4 \rightarrow 3A$

Reading of $A_5 \rightarrow 6A$

Reading of voltmeter = 6 × 5 = 30

SSSQ. Saleem Sir Special Question

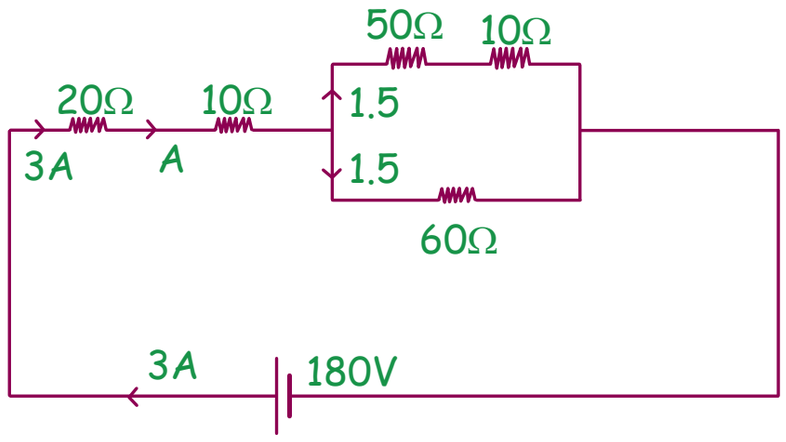
Q.



If reading A_1 — A_2 — & — V

are x, y, z, find $\frac{z}{xy}$

Sol.



$R_{eq} = 20 + 10 + 30 = 60\Omega$

A_1 — $3A = x$

A_2 — $1.5A = y$

V — $= 75$ volt $= z$

$$\frac{z}{xy} = \frac{75}{3 \times 1.5} = 16.6$$

अब हम R_{eq} निकालना सीखेंगे

- If resistance are in series then

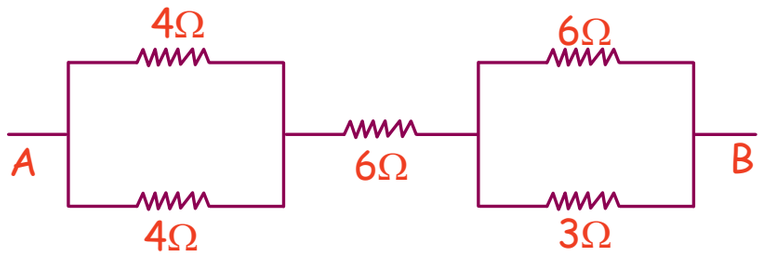
  $R_{eq} = R_1 + R_2 + R_3 + ...$

- If resistance in parallel

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

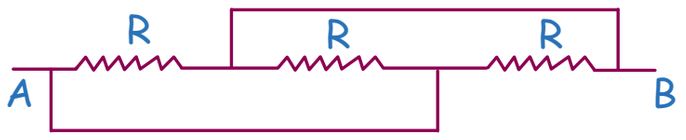
- If R_1 and R_2 are in parallel then $R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

Q. Find R_{eq}

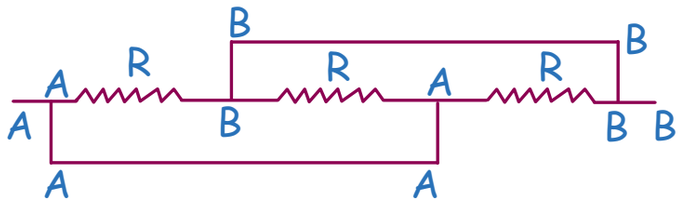


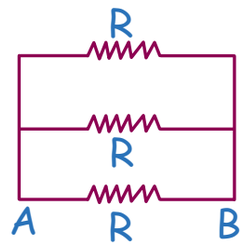
$R_{eq} = 2 + 6 + 2 = 10\Omega$

Q. Find R_{eq} between A and B.



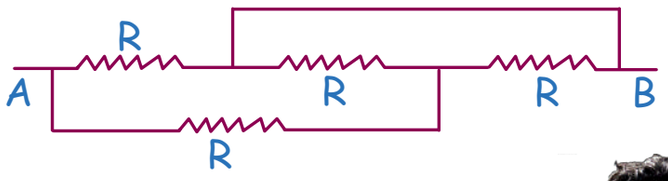
Sol.



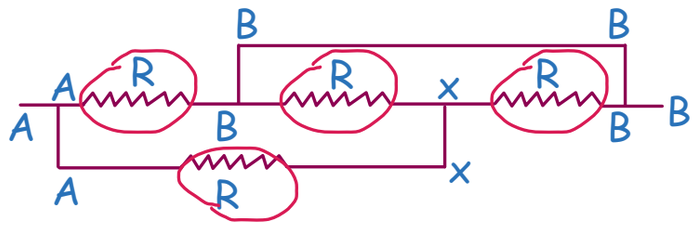


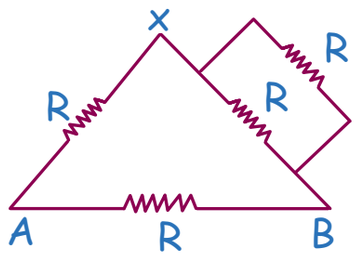
$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R} \qquad R_{eq} = R/3$$

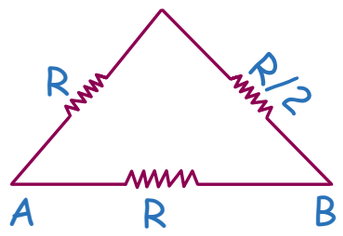
Q. Find R_{eq} between A and B.

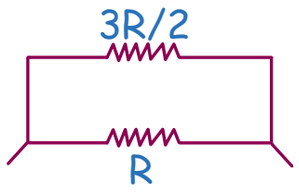


Sol. जहाँ फसो वहाँ x को याद करो और उसके खराब, बेकार, डरावनी सूरत को सूधार लो..... अबे मतलब नया circuit diagram बनाओ।



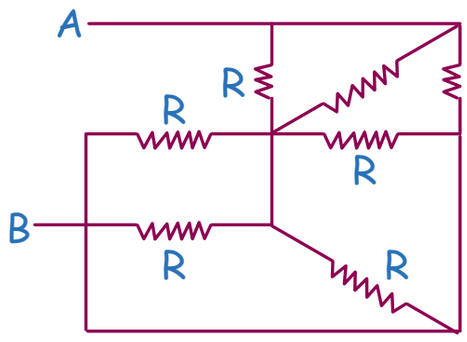




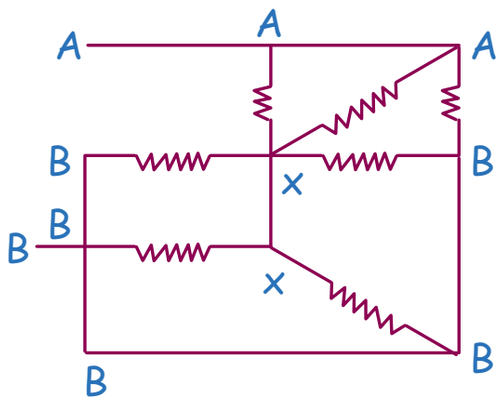


Ans. $R_{eq} = 0.6R$

Q. Find the R_{eq} between A and B.

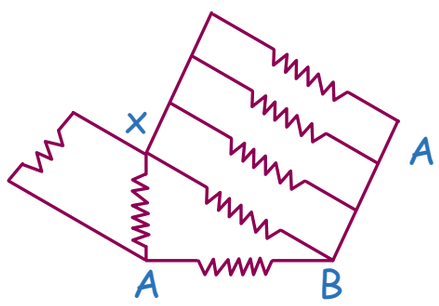


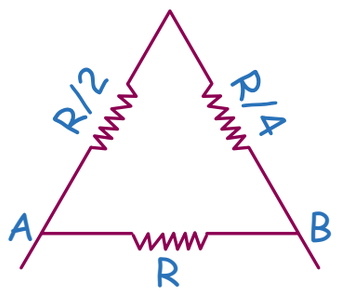
Sol. Resistance RΩ each



All resistance are equal (RΩ)

R_{AB} = ?

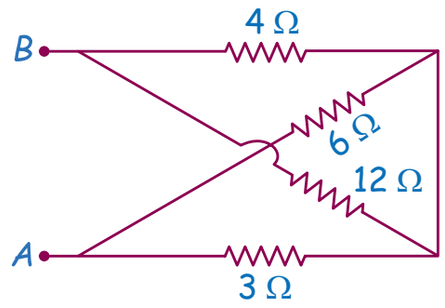




$$R_{eq} = \frac{\frac{3R}{4} \times R}{\frac{3R}{4} + R} = \frac{3}{7}R$$

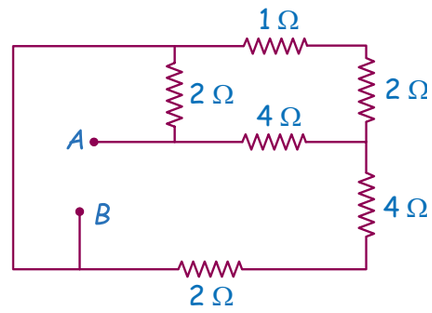
Homework

Q. In the given network, the equivalent resistance between A and B is



Ans. 5

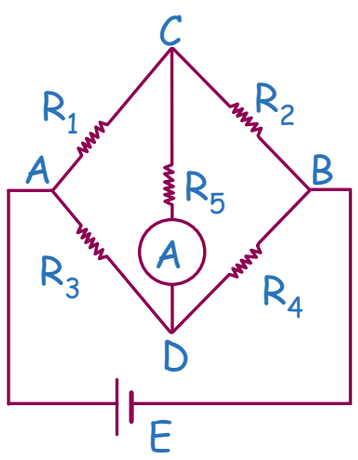
Q. In the circuit shown in figure, equivalent resistance between A and B is



Ans. 1.5

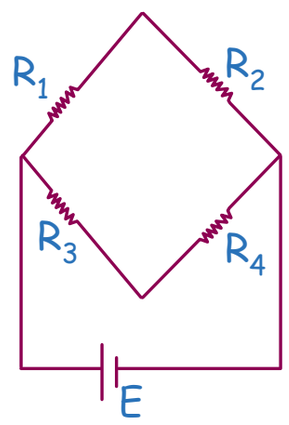
Wheatstone Bridge

☆ In following circuit

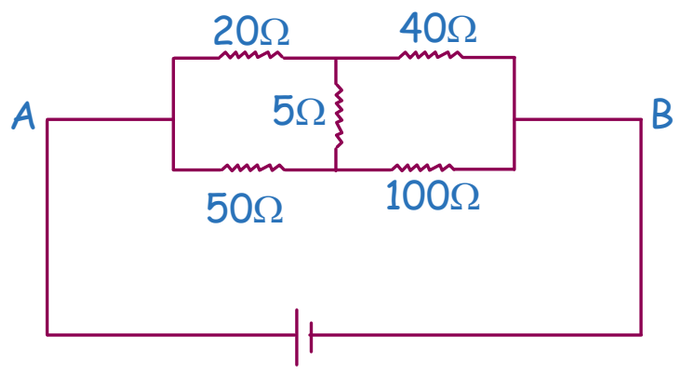


If $\frac{R_1}{R_2} = \frac{R_3}{R_4}$ then be observed that $V_C = V_D$ and current through R_5 is zero तो R_5 को circuit से उड़ा दो such type of circuit called balance wheatstone bridge

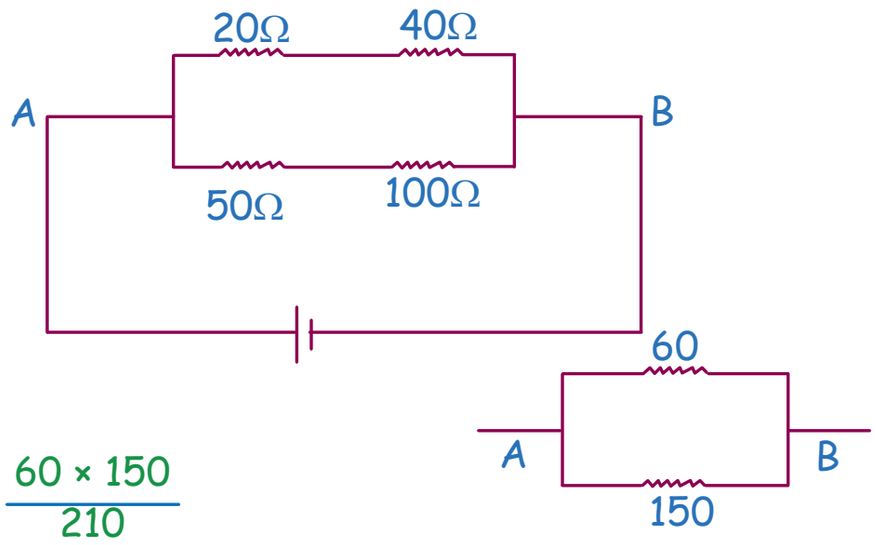
⇒



Q. Find R_{eq} between A & B

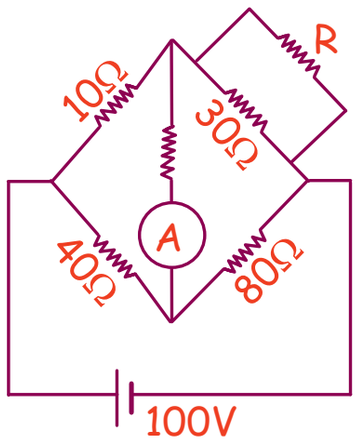


Sol.



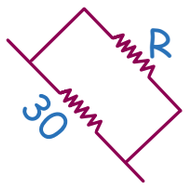
$$R_{AB} = \frac{60 \times 150}{210}$$

Q. Find value of R for which ammeter reading is zero



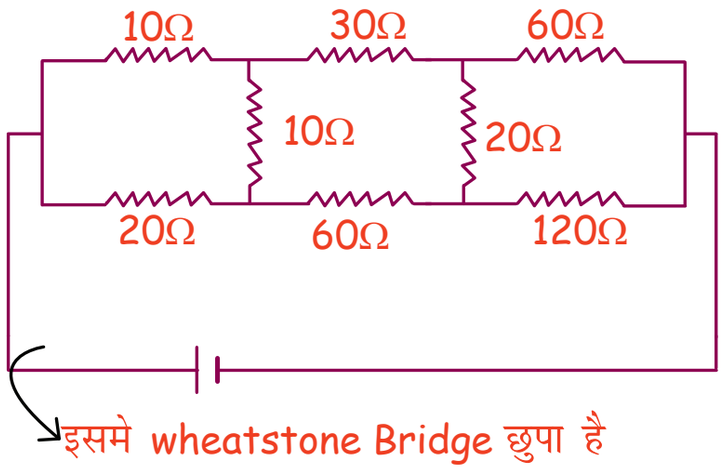
Sol.

R = 60



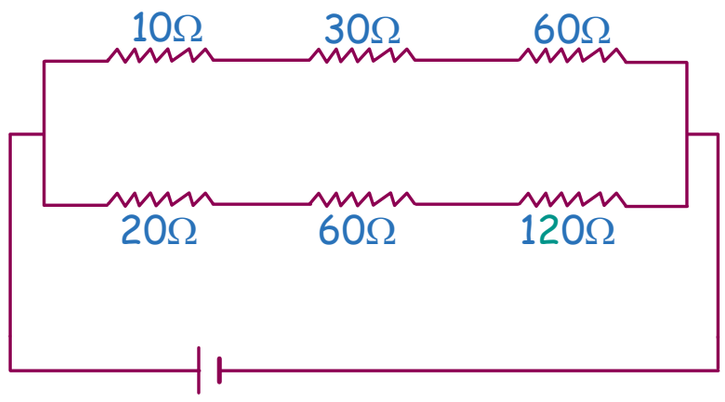
⇒ 20 Ω होना चाहिए

Q. Find equivalent resistance.

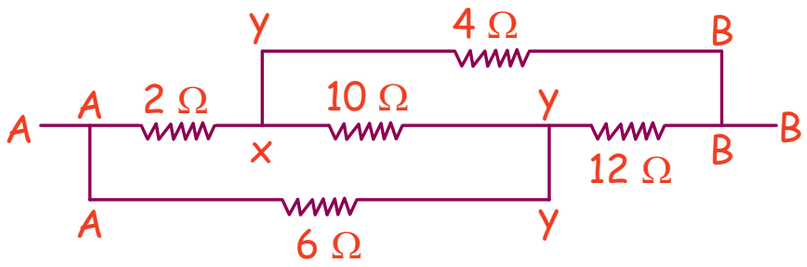


इसमे wheatstone Bridge छुपा है

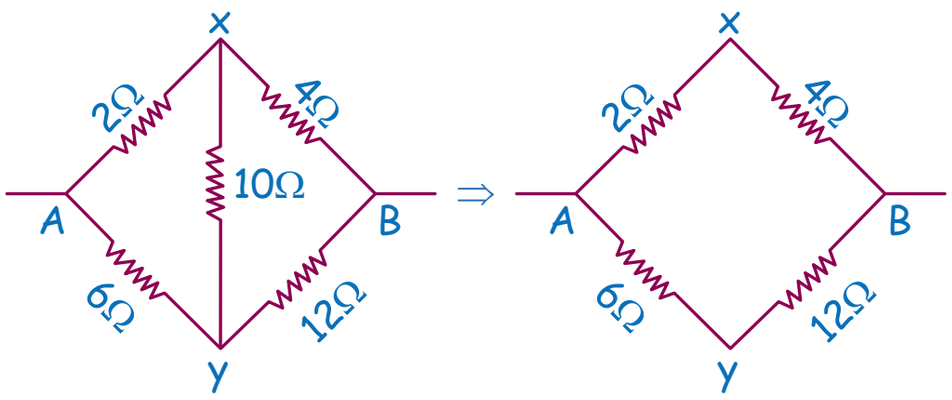
Sol.



Q. find R_{AB} = ?



Sol.



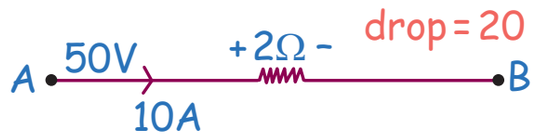
$$R_{eq} = \frac{6 \times 18}{6 + 18} = \frac{6 \times 18}{24} = 4.5$$

Kirchhoff Voltage Law (KVL)

$V_A - V_B = 10$

$V_A - V_B = iR$

$V_A - iR = V_B$



$V_A - iR = V_B$

$50 - 10 \times 2 = V_B$

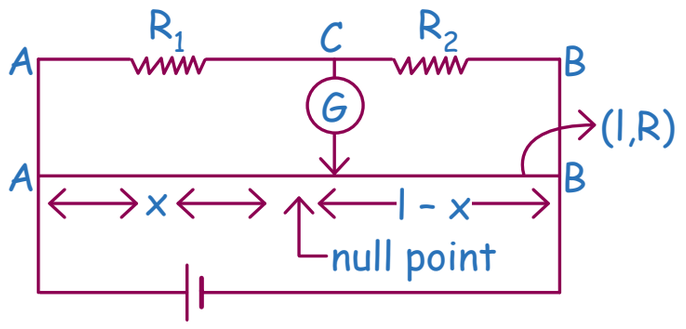
$V_B = 30$

Meter Bridge

- It is used to find unknown resistance.
- Its concept based on balance wheat stone bridge.
- When current through galvanometer is Zero.

$$\frac{R_1}{R_2} = \frac{R_{AD}}{R_{DB}} = \frac{x}{l - x} \qquad (l = 100 \text{ cm})$$

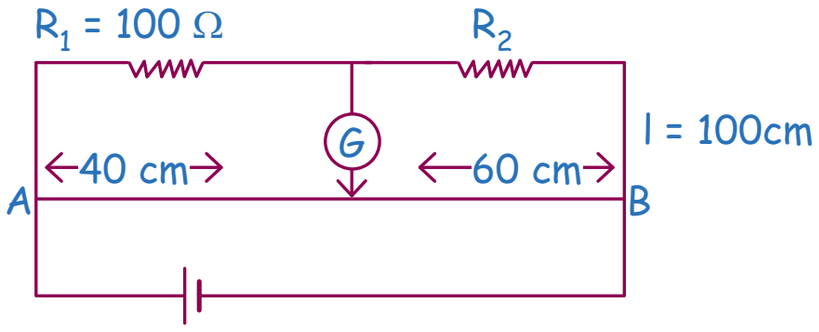
$$\boxed{\frac{R_1}{R_2} = \frac{x}{l - x}}$$



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

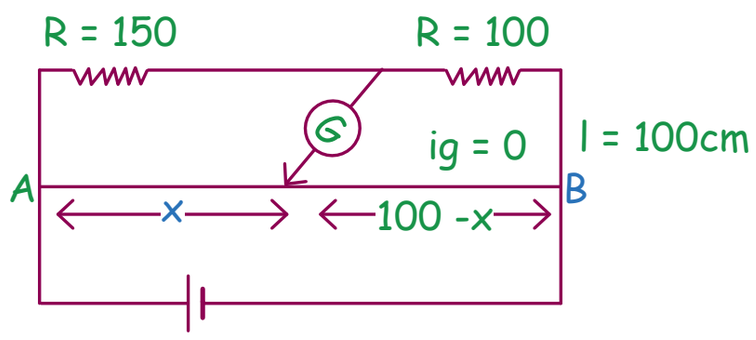
$R \propto$ length

Q. In a meter bridge (as shown in fig), if null point is found at a distance of 40 cm from A. Find shift in the null point if R_1&R_2 interchanged



Sol. $\frac{R_1}{R_2} = \frac{40}{60}$

$\frac{100}{R_2} = \frac{40}{60} \Rightarrow \boxed{R_2 = 150}$



$\frac{150}{100} = \frac{x}{100 - x}$

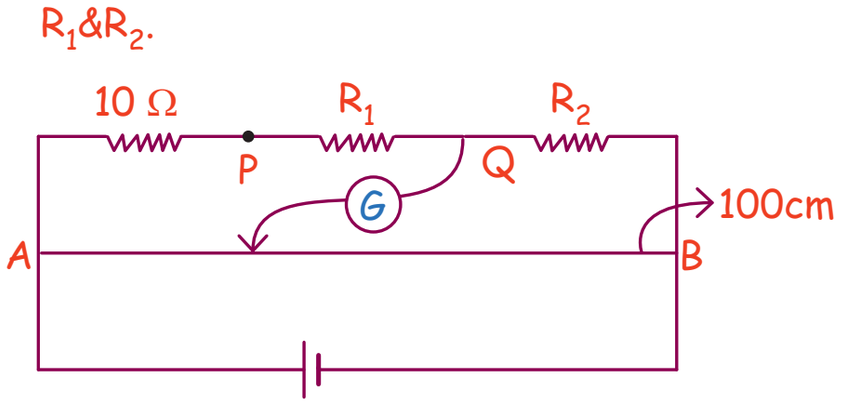
$\frac{3}{2} = \frac{x}{100 - x}$

$300 - 3x = 2x$

$x = 60$

Ans. shift = 60 – 40 = 20cm

Q. When galvanometer is connected to point P, null point at a distance 40 cm. From point A when galvanometer is connected to point Q, null point is found at a distance 30cm from end B. Find R_1&R_2.



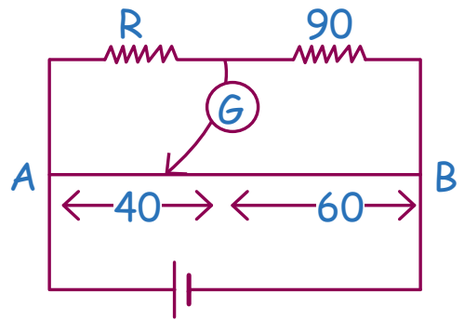
Sol. $\frac{10}{R_1 + R_2} = \frac{40}{60}$ ...(1)

$\frac{10 + R_1}{R_2} = \frac{70}{30}$ ...(2)

Solve and get $\boxed{R_1 = R_2 = 7.5\Omega}$

Q. In a meter Bridge find value of R if end correction are 1cm & 3cm at end A & end B

Sol.



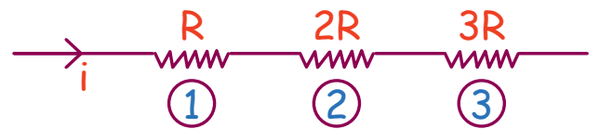
$\frac{R}{90} = \frac{40 + 1}{60 + 3}$

POWER DISSIPATED ACROSS RESISTANCE

- Power dissipated across the resistance = i^2R
- $P = V.i = iR.i = i^2R = \frac{V^2}{R}$
- $H = \int_0^t i^2R\,dt$
- If current is constant heat = i^2Rt

Q. Find the order of power dissipated across the resistance in following question.

(a)

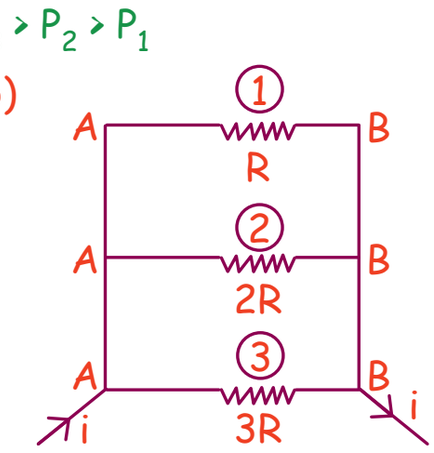


Sol. $P = i^2R$

$R\uparrow = P\uparrow$ Power loss$\uparrow$

$P_3 > P_2 > P_1$

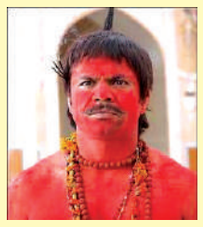
(b)



Sol. $V \rightarrow$ same

$P = \frac{V^2}{R}$ $\quad R\uparrow = P\downarrow$

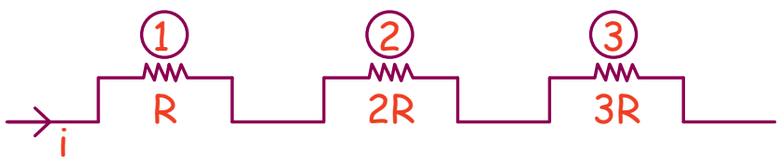
$P_3 < P_2 < P_1$



Student: sir ये बताओ कि कब $P = i^2R$ लगाना है कब $P = v^2/R$ लगाना है।

फिर भी अगर resistance series में है तो $P = i^2R$ try करो और अगर resistance parallel में है तो $P = V^2/R$ try करो calculation आसान रहेगी।

Q. Three different bulb of resistance R, 2R, 3R are in series as shown in figure. Find order of their brightness.



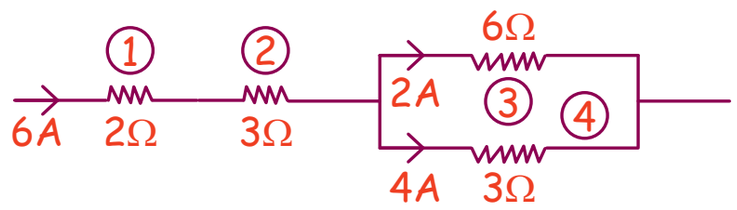
Sol. $i \rightarrow$ same $\quad P = i^2R$

$P \rightarrow P_3 > P_2 > P_1$

Brig $\rightarrow B_3 > B_2 > B_1$

Bulb के case मे जिसके across power ↑ तो Brightness ↑

Q. Repeat the above problem in following case.



Sol. $P_1 = 6^2 \times 2 = 72$

$P_2 = 6^2 \times 3 = 108$

$P_3 = 2^2 \times 6 = 24$

$P_4 = 4^2 \times 3 = 48$

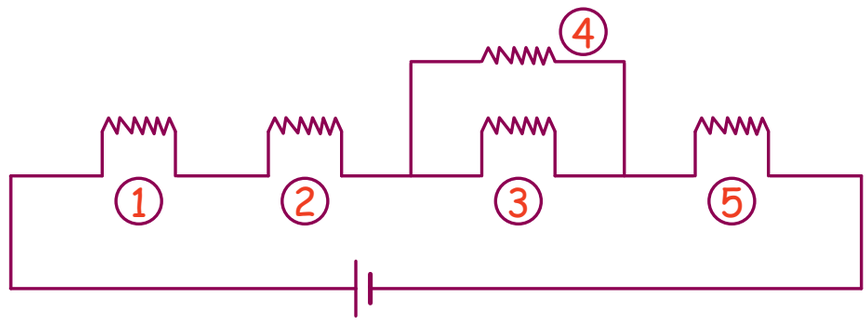
$P_2 > P_1 > P_4 > P_3$

Brightness $B_2 > B_1 > B_4 > B_3$

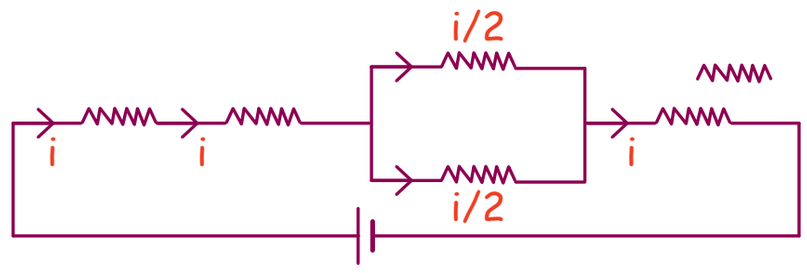
Q. Compare brighten of bulb

All are identical bulb

$R \rightarrow$ same

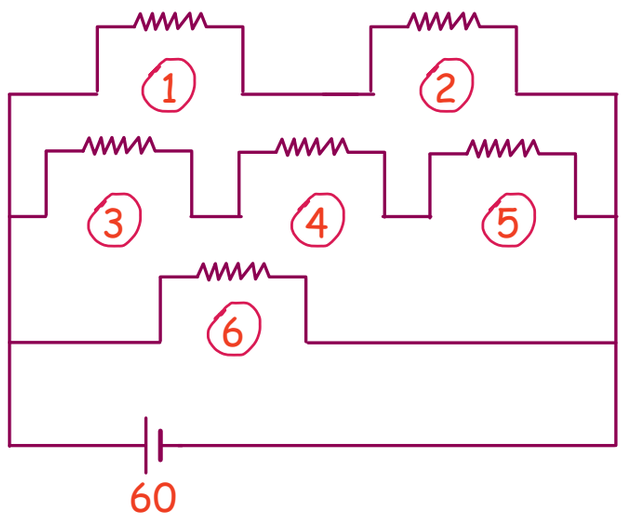


Sol.

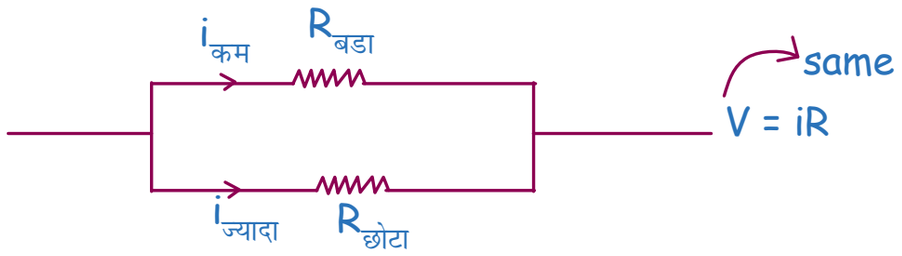


$B_1 = B_2 = B_5 > B_4 = B_3$

Q. All bulbs are indentical having same resistance 10Ω. Find order of brightness

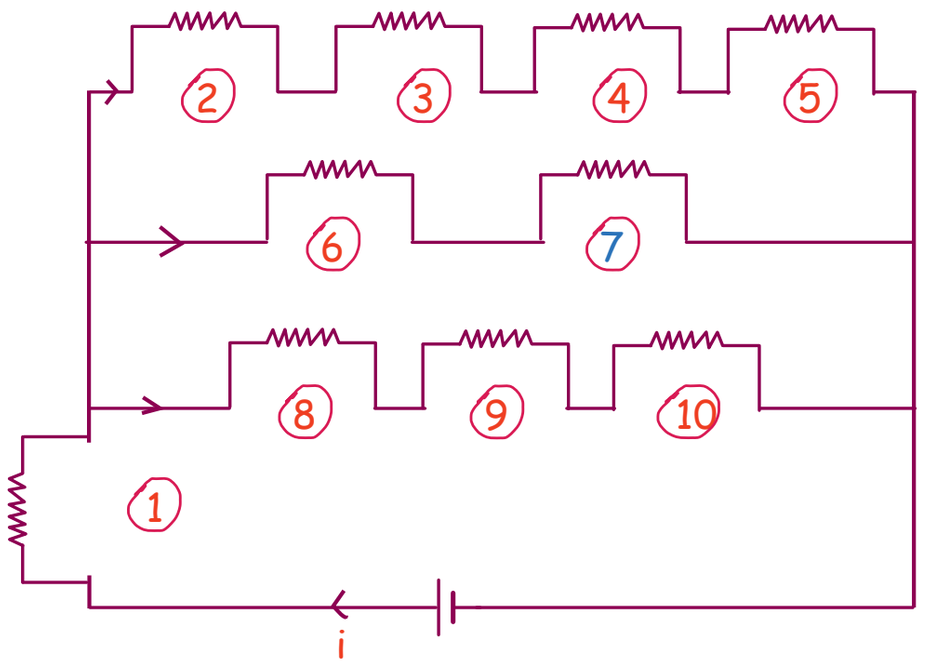


Sol. $B_6 > B_1 = B_2 > B_3 = B_4 = B_5$



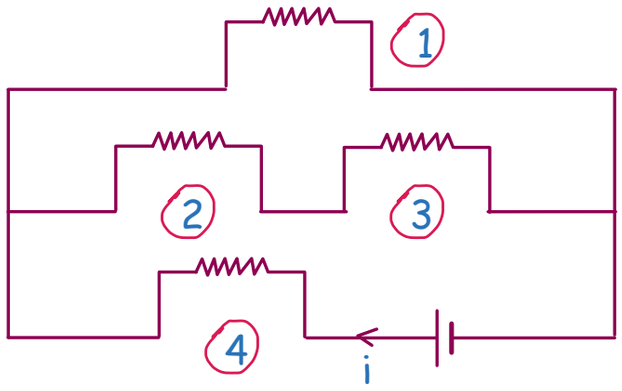
Q. All are identical

(a)



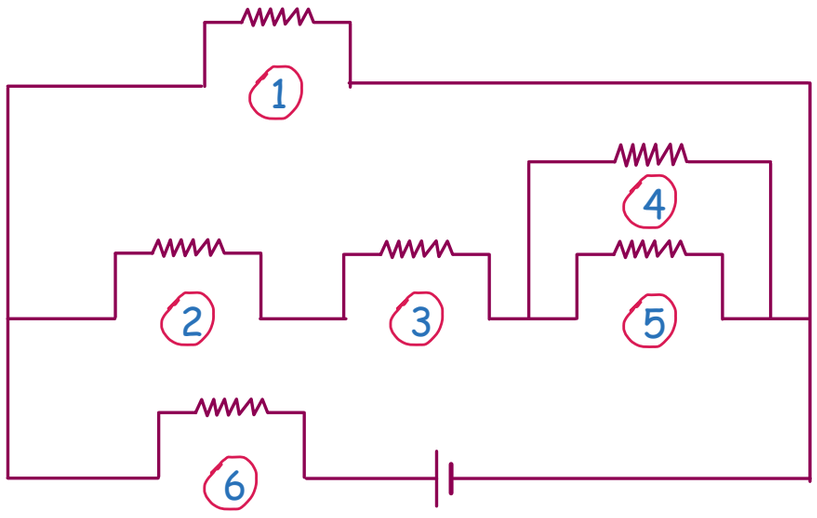
Sol. $B_1 > B_6 = B_7 > B_8 = B_9 = B_{10} > B_2 = B_3 = B_4 = B_5$

(b) All bulbs are identical



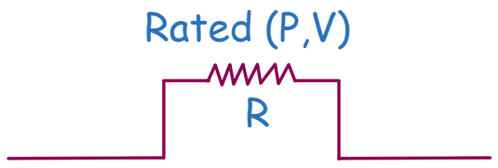
Sol. $B_4 > B_1 > B_2 = B_3$

(c)



Sol. $B_6 > B_1 > B_2 = B_3 > B_4 = B_5$

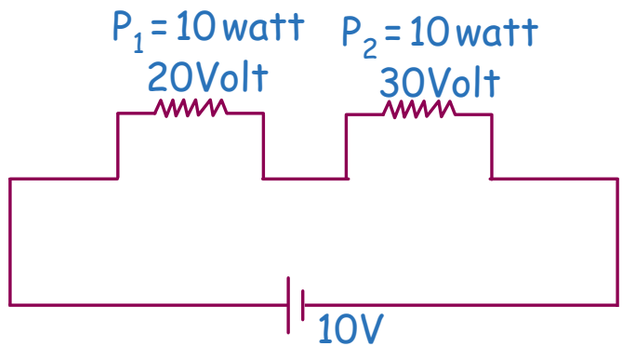
Bulb

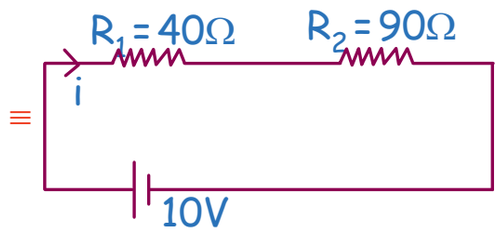


Suppose it's given that rated voltage of bulb is V and rated power is P it means यह bulb का resistance देने का तरीका है

$$\text{Resistance of bulb} = \frac{V^2}{P}$$

Q. Compare brighter of bulbs.





Sol. $R = \frac{V^2}{P} \Rightarrow R_1 = \frac{(20)^2}{10} = 40\Omega$

$$i = \frac{10}{130}$$

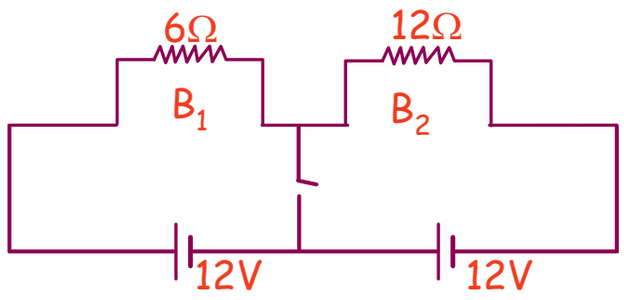
$$R_2 = \frac{(30)^2}{10} = 90\Omega$$

Power across $B_1 = i^2R_1 = (1/13)^2 \times 40$

$B_2 = i^2R_2 = (1/13)^2 \times 90$

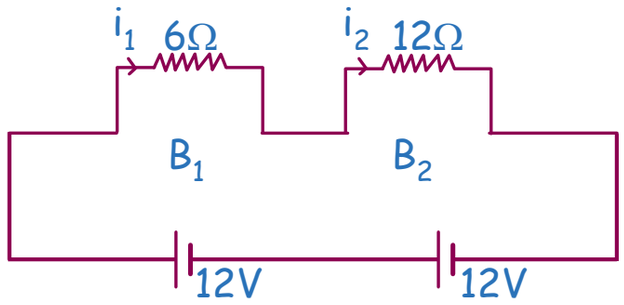
$B_2 > B_1$ (or $i \rightarrow$ same $\Rightarrow$ जिसका R↑ उसकी P↑B↑).

Q. B_1 and B_2 are bulbs. What happens to brightness of bulbs after switch close?



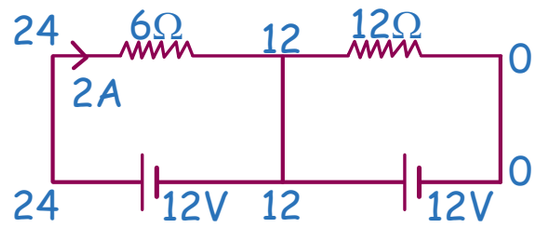
1. Brightness of B_1 inc
2. Brightness of B_1 dec
3. Brightness of B_2 inc
4. Brightness of B_2 dec

Sol. Before switch is close



$i_1 = i_2 = 1.33$

Now after switch is closed.



$i_1 = 2$ and $i_2 = 1$

We observed that after switch is closed current through B_1 increased hence power across bulb B_1 increased similarly current across bulb 2 decrease. Hence power across bulb 2 decrease.

Ans: 1 & 4

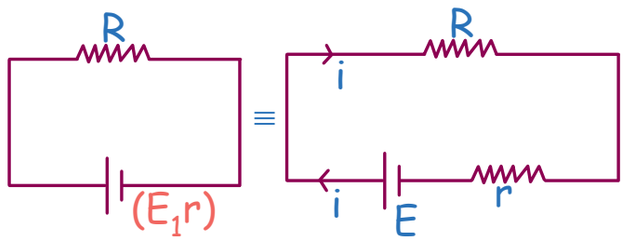
- When connected voltage and rated voltage are same then total power dissipated for *n* number of bulbs in series,

$$\frac{1}{P_T} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} + ... + \frac{1}{P_n}$$

- When connected voltage and rated voltage are same then total power dissipated for *n* number of bulbs in parallel,

$$P_T = P_1 + P_2 + P_3 + ... + P_n$$

Max Power Theorem



Power dessipited across $R = i^2R = \left(\frac{E}{R+r}\right)^2 R$

$$P = \frac{E^2R}{(R+r)^2}$$

At what condition $P \to$ max

Do $\frac{dP}{dR} = 0 \Rightarrow$ Solve and get $R = r$

So maximum power will be delivered to load R if value is equal to that of internal resistance of cell. In above case $P_{max} = E^2/4R$ (after solve).

अब हम KVL लिखना सिखेंगे जिसका आपको बहुत देर से इंतजार है बस नीचे की बाते याद रखो।

$V_A - iR = V_B$

(Resistance में current की दिशा मे iR का drop)

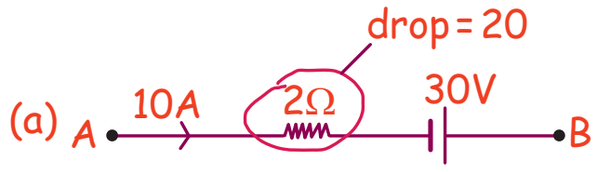
$V_A - V_B = E$

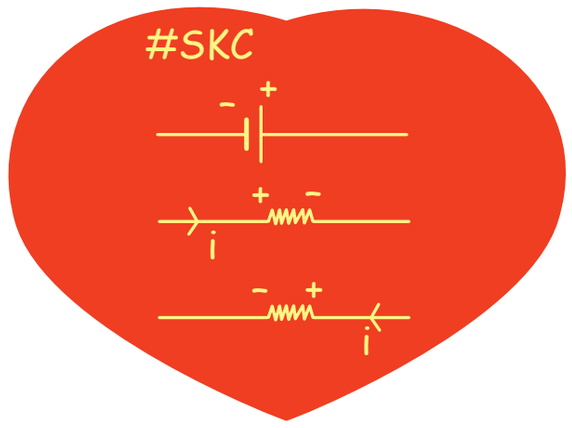
(irrespective of dir^n of current)

$V_B - V_A = E$

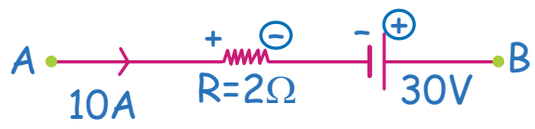
(चाहे current हो या ना हो या कही भी हो)

Q. Find $V_A - V_B$





Sol.

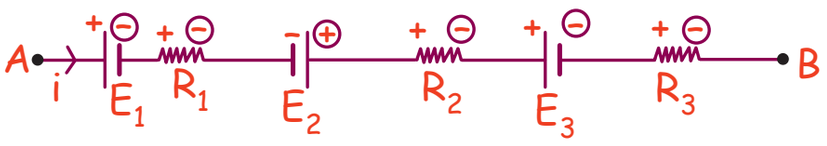


$V_A - iR + E = V_B$

$V_A - 20 + 30 = V_B$

$V_A - V_B = -10$

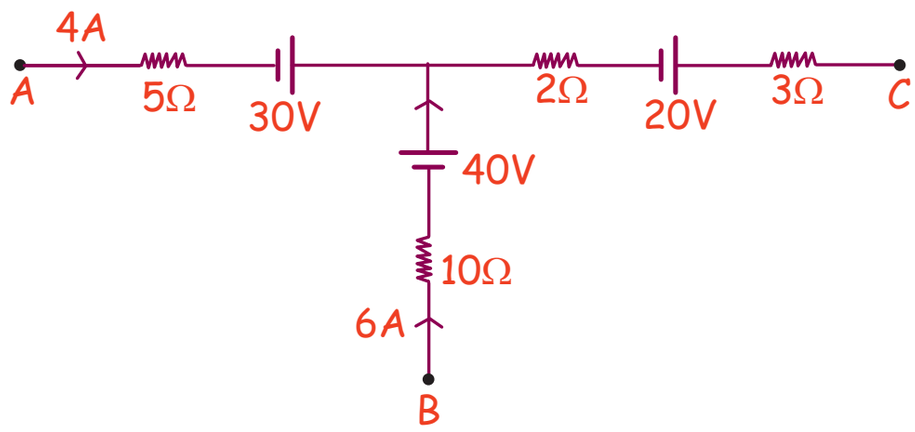
(b)



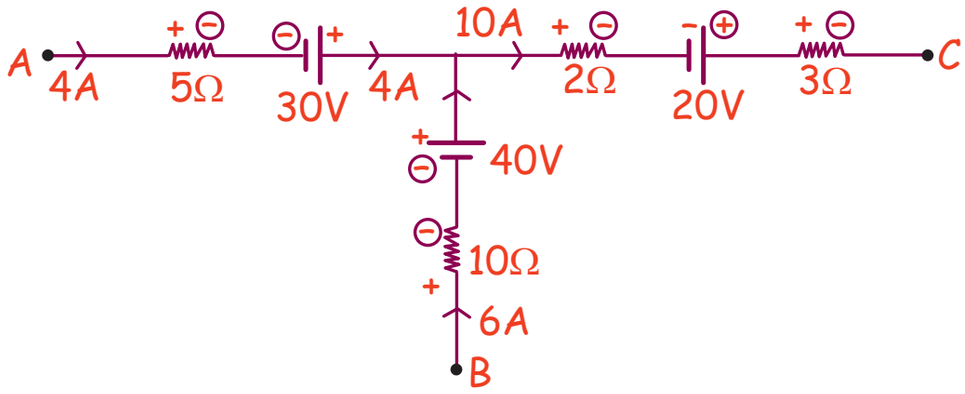
Sol. $V_A - E_1 - iR_1 + E_2 - iR_2 - E_3 - iR_3 = V_B$

$V_A - V_B = ✓$

Q. Find (1) $V_A - V_C$ (2) $V_A - V_B$ (3) $V_B - V_C$



Sol.



(1) $V_A - V_C = ?$

$V_A - 20 + 30 - 10 \times 2 + 20 - 30 = +V_C$

$V_A - V_C = 20$

(2) $V_A - V_B = ?$

$V_A - 20 + 30 - 40 + 6 \times 10 = V_B$

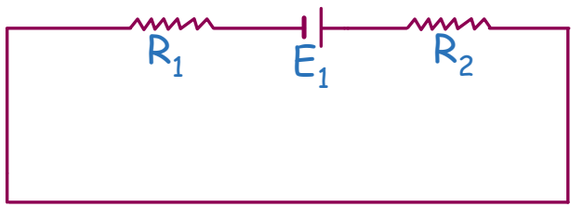
$V_A - V_B = -30$

(3) $V_B - V_C = ?$

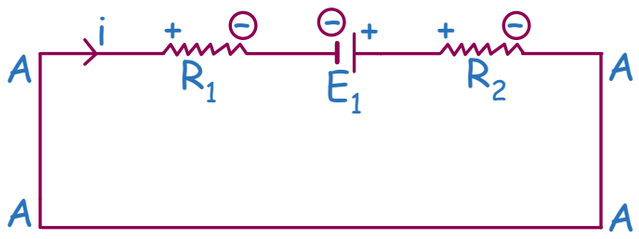
$V_B - 60 + 40 - 20 + 20 - 30 = V_C$

$V_B - V_C = 50$

Q. Find current in the circuit.



Sol.

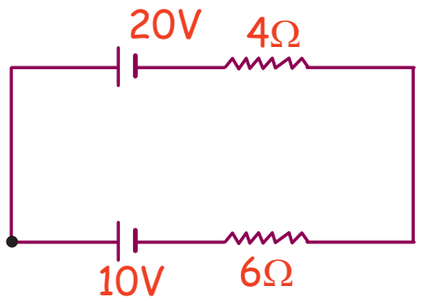


$V_A - iR_1 + E_1 - iR_2 = V_A$

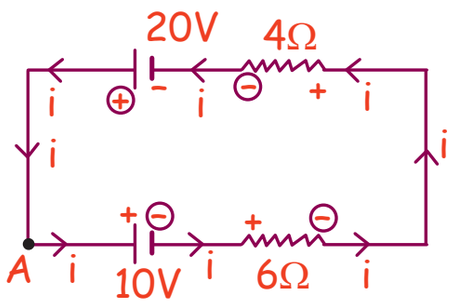
$E_1 = iR_1 + iR_2$

$$i = \frac{E_1}{R_1 + R_2}$$

Q. Find current in the circuit.



Sol.



$V_A - 10 - 6i - i \times 4 + 20 = V_A$

$-10 - 10i + 20 = 0$

$i = 1A$

थोड़ी देर के बाद हम देखेंगे 20 V battery is discharging and 10 V batter is charging in this case.

#SKC

i→ loop में Cω/Acω

जो दिल चाहे मान लो अगर

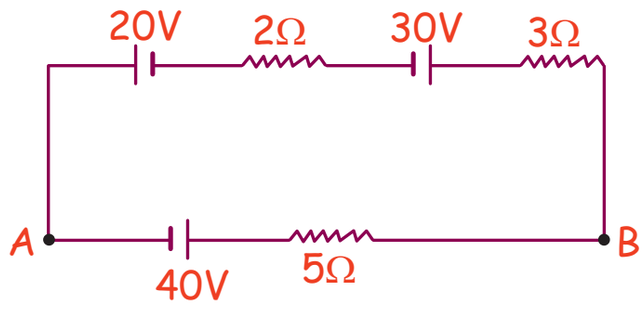
गलत direction मानी तो

current negative

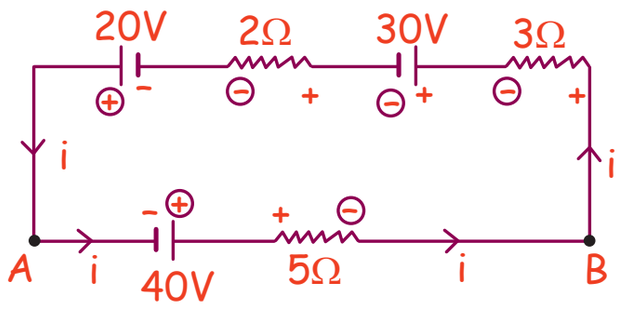
आ जाएगा

Q. (1) Find current in circuit

(2) $V_A - V_B = ?$



Sol.



(1) i→ Acw मान लो (let)

$V_A + 40 - 5i - 3i - 30 - 2i + 20 = V_A$

$i = 3A$

(2) $V_A + 40 - 3 \times 5 = V_B$

$V_A - V_B = -25$

✦

1. A से B चलते है

$V_A - 30 + 2 \times 10 = V_B$

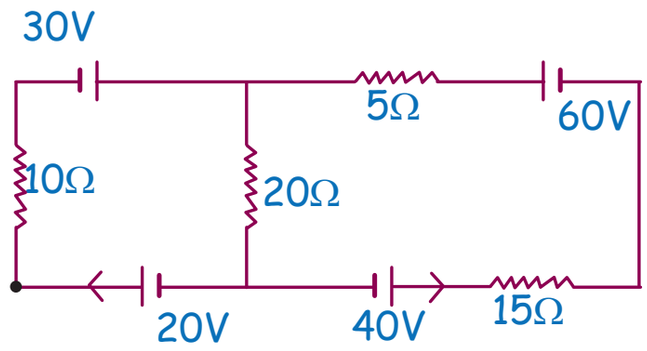
$V_A - V_B = 10V$

2. B से A चलते है

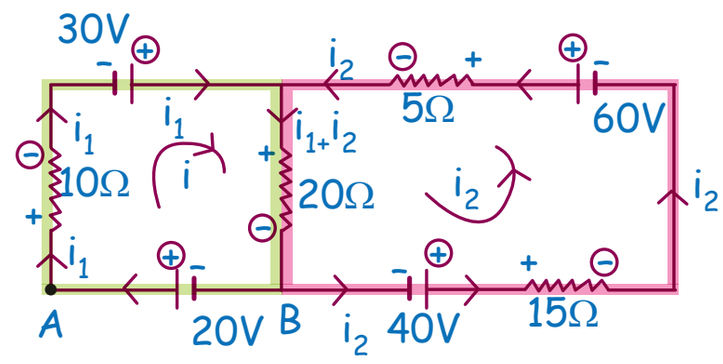
$V_B - 2 \times 10 + 30 = V_A$

$V_A - V_B = 10$

Q. Find current in each in each resistors



Sol.



$V_A - 10i + 30 - (i_1 + i_2) \times 20 + 20 = V_A$

$-10i_1 + 30 - (i_1 + i_2) \times 20 + 20 = 0$ ...(1)

$VB + 40 - 15i_2 + 60 - 5i_2 - (i_1 + i_2) \times 20 = VB$

$40 - 15i_2 + 60 - 5i_2 - (i_1 + i_2) \times 20 = 0$ ...(2)

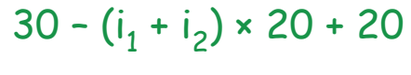
Solve (1) & (2) And get Ans:

Charging & Discharging of Batteries

#SKC

अगर battery के बड़े डंडे से बाहर current निकल रहा है तो battery discharge हो रही है और बड़े डंडे के अंदर current आ रहा है तो battery charge हो रही है

Discharge of battery



Charging of battery

Charging of battery

$V_A - E - ir = V_B$

$V_A - V_B = E + ir$

(Pot diff across battery, terminal voltage)

Discharging of battery

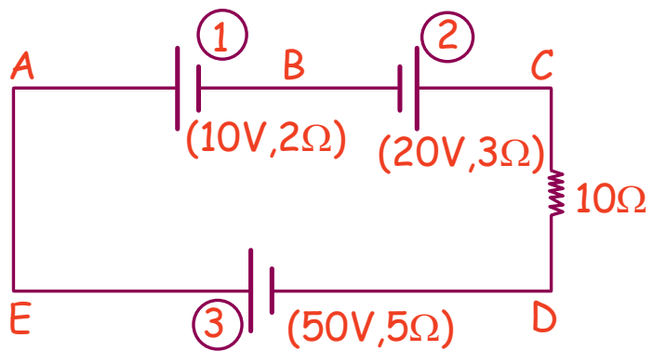
$V_A - E + ir = V_B$

$V_A - V_B = E - ir$

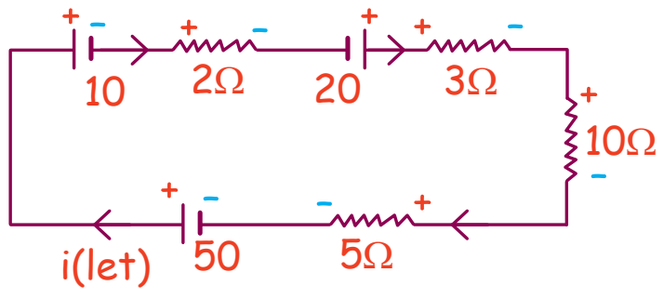
(Pot diff across battery, terminal voltage)

अब पिछले page में SKC के पास वाले questions solve करो और देखो कौनसी battery charge हो रही है और कौनसी discharge.

Q. Find potential difference across each battery



Sol.



$V_A - 10 - 2i + 20V - 3i - 10i - 5i + 50 = V_A$

$60 = 2i$

$\boxed{i = 3A}$

(1) → Charging 2, 3 → discharge

Potential diff across each battery

$|V_{AB}| = E + ir = 10 + 3 \times 2 = 16V$

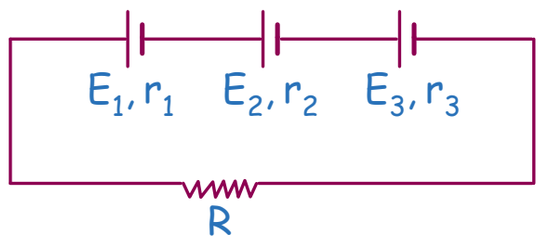
$|V_{BC}| = |E - ir| = |20 - 3 \times 3| = 11V$

$|V_{ED}| = |50 - 3 \times 5| = 35$

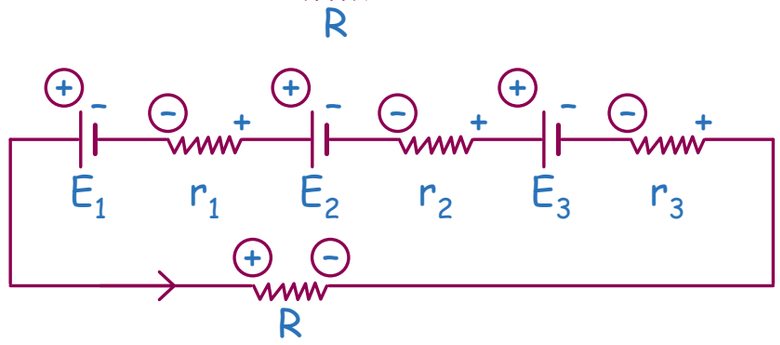
#SKC

Battery के internal resistance से बिलकुल नही डरना है बस battery के बाजू मे उतना resistance लगा देना है

Q. Find current in circuit



Sol.

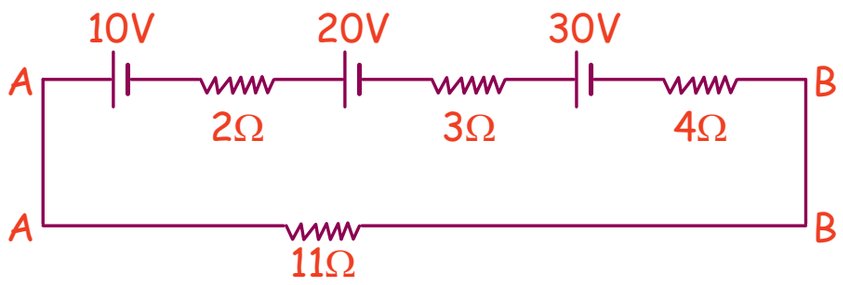


$-iR - iR_3 + E_3 - iR_2 + E_2 - iR_1 + E_1 = 0$

$$i = \frac{E_1 + E_2 + E_3}{r_1 + r_2 + r_3 + R}$$

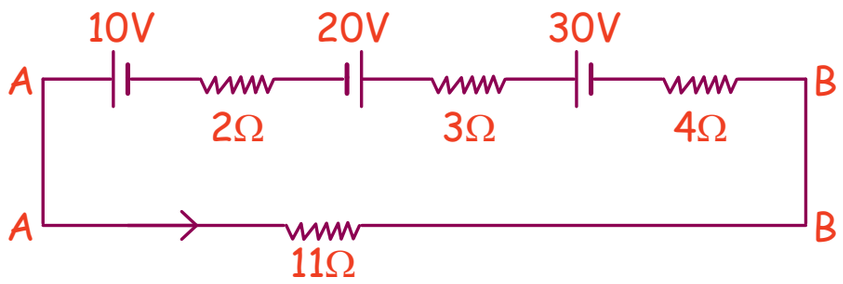
$$i = \frac{E_1 + E_2 + \ldots}{(r_1 + r_2 + \ldots) + R}$$

Q. Find current in circuit



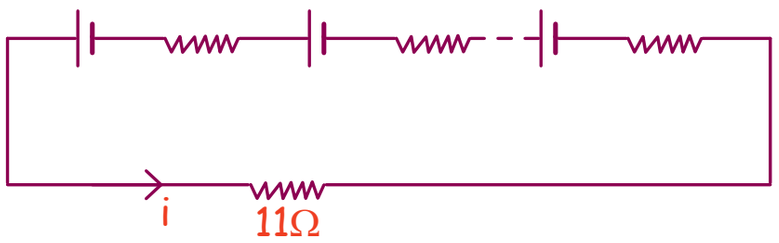
Sol. $i = \dfrac{10 + 20 + 30}{2 + 3 + 4 + 11}$ $\quad V_{AB} = \checkmark$

Q. Find current in circuit



Sol. $i = \dfrac{10 - 20 + 30}{2 + 3 + 4 + 11}$

Q. (a) n indentical cells are connected in series as shown in diagram. Find i through R



Sol. $i = \dfrac{E + E + \ldots}{(r + r + r \ldots)R} = \dfrac{nE}{nr + R}$

(b) If one cell is reversed find current in R

Sol. $\boxed{i = \dfrac{nE - 2E}{nr + R}}$

(c) If m battery reversed

Sol. $i = \dfrac{nE - 2mE}{nr + R} = \dfrac{(n - 2m)E}{nr + R}$

Results

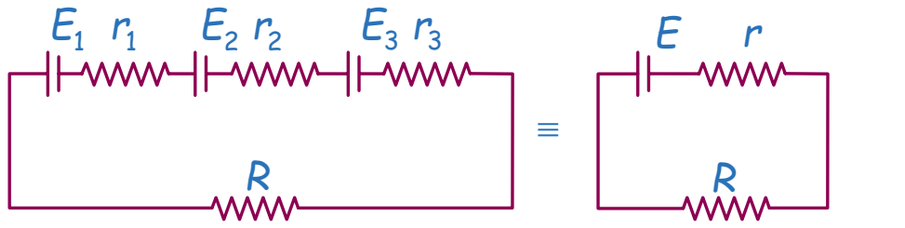
(i) Series Combination

If n sources of emf are connected in series with same polarity, then the equivalent emf is given by

$E = E_1 + E_2 + E_3 + \ldots\ldots\ldots + E_n$

And, total internal resistance is

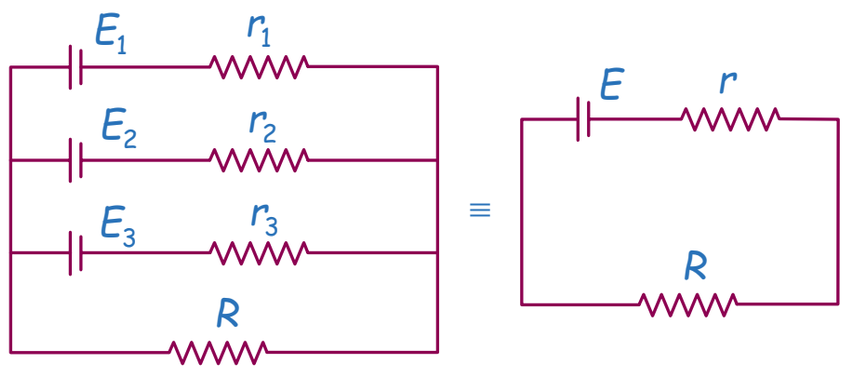
$r = r_1 + r_2 + r_3 + \ldots\ldots\ldots\ldots + r_n$



✦ If there are 'n' identical cells with emf E and internal resistance 'r' and they are connected in such a way that p cells are connected in opposite polarity then,

$E_{net} = (n - 2p)E$ and $r_{net} = nr$

(ii) Parallel Combination



The emf and internal resistance of the equivalent battery are given by

$$E = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2} + \frac{E_3}{r_3}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}}$$

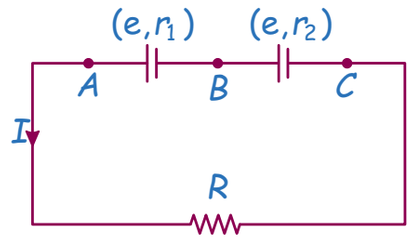
and $\dfrac{1}{r} = \dfrac{1}{r_1} + \dfrac{1}{r_2} + \dfrac{1}{r_3}$

मेरे सपने में आई सुन्दर परी.....

And नीचे वाला questions is compulsory

Q. Two batteries having the same emf ε but different internal resistances r_1 and r_2 are connected in series in same polarity with an external resistor R. For what value of R does the potential difference between the terminals of the first battery become zero?

Sol.



Net resistance in the circuit is $(r_1 + r_2 + R)$.

Current in the circuit

$$I = \frac{2\varepsilon}{(r_1 + r_2 + R)}$$

The potential difference between the terminals of first battery is $(V_A - V_B)$. Terminal potential difference is given by

$$(V_A - V_B) = \varepsilon - Ir_1$$

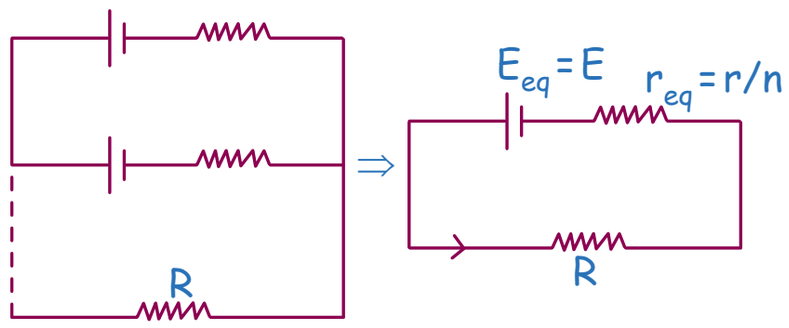
$$V_A - V_B = \varepsilon - \frac{2\varepsilon r_1}{r_1 + r_2 + R} = \varepsilon\frac{(R + r_2 - r_1)}{(R + r_2 + r_1)}$$

For $(V_A - V_B)$ to be zero, we must have

$$R = (r_1 - r_2)$$

This gives meaningful result only if $r_1 > r_2$. Otherwise, if $r_2 > r_1$, then $R = r_2 - r_1$ will produce terminal voltage across second cell to be zero $(V_{BC} = 0)$.

✦ If n identical (E, r) cells are in parallel



$$i = \frac{E}{\frac{r}{n} + R}$$

$$E_{eq} = \frac{E/r + E/r + \ldots \text{ n times}}{1/r + 1/r + \ldots \text{ n times}}$$

$$\boxed{E_{eq} = E}$$

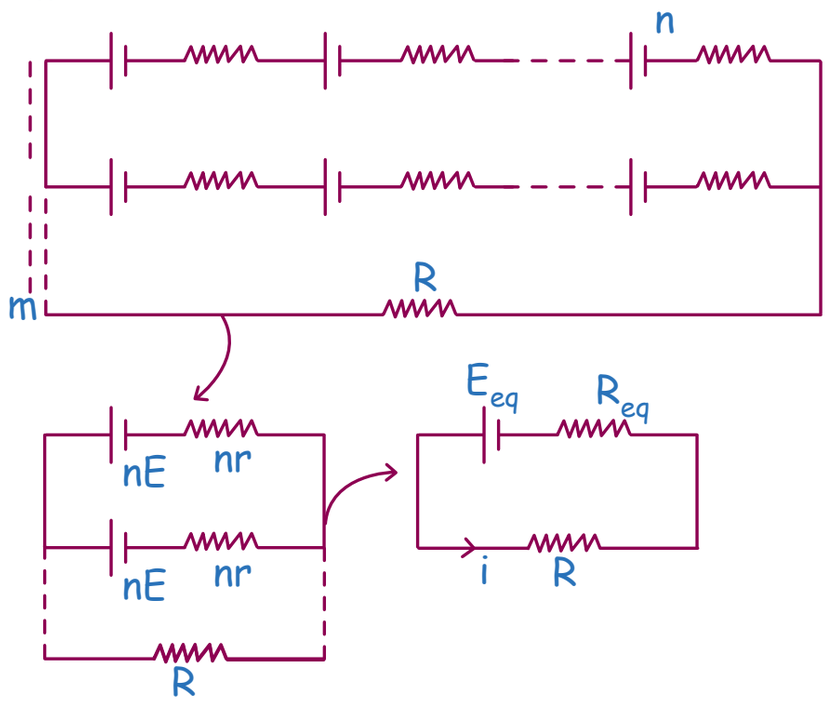
$$\frac{1}{Req} = \frac{1}{r} + \frac{1}{r} + \ldots \text{ n times}$$

$$\boxed{req = \frac{r}{n}}$$

✦ Mixed Grouping

n identical cell in row in series

m → no of row



net emf = nE

$$\text{Total internal resistance} = \frac{nr}{m}$$

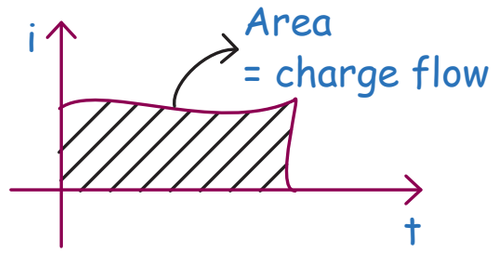
$$i = \frac{nE}{\frac{nr}{m} + R}$$

अब हम पढ़ेंगे वो चीज जो सारी दुनिया इस chapter मे सबसे पहले पढ़ती है।

Current Electricity

$$\text{Current} = i = \frac{dq}{dt} = \text{Rate of flow of charge}$$

$$\Delta q = \int i\,dt$$

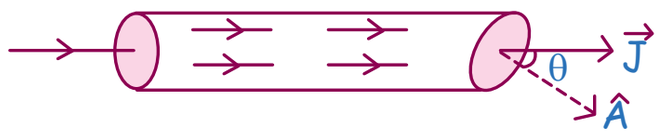


Conventionally direction of flow of current is taken to be in direction of flow of +ve charge

If moving charge is negative (जैसे electron) current direction is opposite to direction of motion of charge.

Current Density

- ✦ It is the current flowing per unit area normal to the surface
- ✦ vector quantity
- ✦ Flux of current density is current
- ✦ It's direction is same as direction of current



$$i = \vec{J}.\vec{A} = JA\cos\theta$$

$$\Rightarrow \quad J = \frac{i}{A\cos\theta}$$

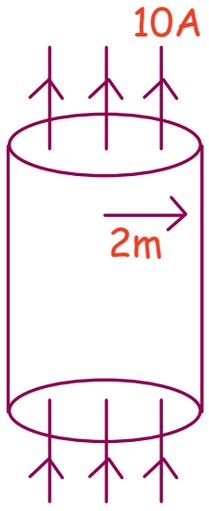
For special case

$\theta = 0$

$$i = JA \Rightarrow \boxed{J = \frac{i}{A}}$$

$i = \int \vec{J}.d\vec{A}$ अगर J बदला तो we will use this

Q.

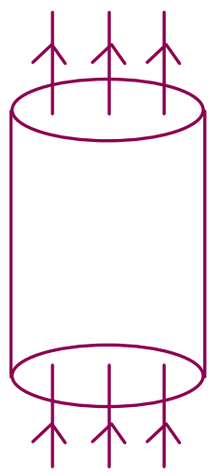


Sol. $\vec{J} = \frac{10}{\pi 2^2}\hat{i}$

$\phi = \int E \cdot d\vec{A}$

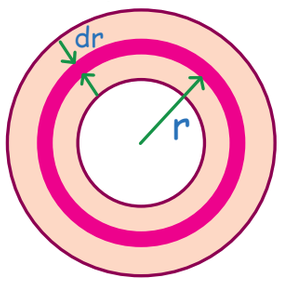
Current density का flux $= \int \vec{J} \cdot d\vec{A} = i$

Q. If $J = J_0 r$, Find total current flowing through long cylindrical wire



Sol. r पर जाके dr thickness का एक hollow cylinder पकड़ा suppose इससे di current पास किया।

Top view



$di = \vec{J} \cdot d\vec{A}$

$\int di = \int_0^R J_0 r 2\pi r.dr$

$i = J_0 2\pi \frac{R^3}{3}$

MOTION OF ELECTRON INSIDE CONDUCTOR

In absence of applied potential difference electrons have random motion.

All the free electrons are in random motion due to the thermal energy and follow the relationship given by

$$\frac{3}{2}k_B T = \frac{1}{2}mv^2$$

where, k_B = Boltzmann's constant

At room temperature their speed is around 10^6 m/s but the average velocity is zero, so net current is also zero.

Mean Free Path

The average distance travelled by a free electron between two consecutive collisions is called as mean free path λ.

Mean free path $\lambda = \frac{\text{total distance travelled}}{\text{number of collisions}}$

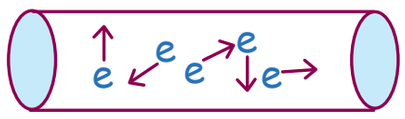
Relaxation Time

The time taken by an electron between two successive collisions is called as relaxation time τ. ($\tau \sim 10^{-14}$ s)

Relaxation time $\tau = \frac{\text{total time taken}}{\text{number of collisions}}$

The thermal speed can be written as $v_T = \frac{\lambda}{\tau}$

Thermal energy Random direct, zigzag path



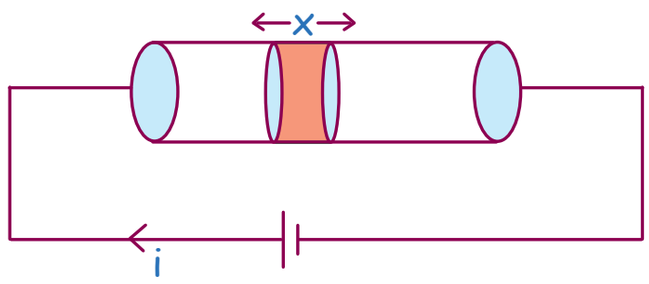
$\vec{u_1} + \vec{u_2} + \vec{u_3} + \ldots \vec{u_A} = 0$

Now battery is applied due which potential different created across conductor result into electric field.

Drift Velocity

- Rate at which random motion of free electron drift in the presence of applied electric field is called velocity (mm/sec order).
- It is the average of velocity of charge carries over the no of charge carrier.
- Drift velocity is v with which the free electron get drifted toward the positive terminal under the effect of applied external Electric field.

Let n → no of electron per unit vol^m



$i = \frac{\Delta q}{\Delta t}$ $\quad \Delta q = nAxe$

$i = \frac{nAxe}{x/v_d} = nAev_d$

Charge on electron

$i = neAV_d$ → Drift velocity

Area of cross section

No. of free e^- per unit vol^m

Derivation for Drift Velocity, J

$$\vec{v}_1 = \vec{u}_1 + \vec{a}\tau_1$$

where, $\vec{a}$ = acceleration of electron = $\frac{-e\vec{E}}{m_e}$

τ = Relaxation time

Similarly for other electrons:

$$\vec{v}_2 = \vec{u}_2 + \vec{a}\tau_2$$

$$\vec{v}_n = \vec{u}_n + \vec{a}\tau_n$$

Average velocity of all the free electrons in the conductor is equal to the drift velocity $\vec{v}_d$ of the free electrons.

$$\vec{v}_d = \frac{\vec{v}_1 + \vec{v}_2 + \vec{v}_3 \ldots\ldots\ldots \vec{v}_n}{n}$$

$$= \frac{(\vec{u}_1 + \vec{a}\tau_1) + (\vec{u}_2 + \vec{a}\tau_2) + \ldots..(\vec{u}_n + \vec{a}\tau_n)}{n}$$

$$= \left(\frac{\vec{u}_1 + \vec{u}_2 + \vec{u}_3 + \ldots\vec{u}_n}{n}\right) + \vec{a}\left(\frac{\tau_1 + \tau_2 + \tau_3 + \ldots\tau_n}{n}\right)$$

Since average thermal speed = 0

So, $\frac{\vec{u}_1 + \vec{u}_2 + \vec{u}_3 + \ldots\vec{u}_n}{n} = 0$ and

$\frac{\tau_1 + \tau_2 + \tau_3 + \ldots\tau_n}{n} = \tau =$ average relaxation time.

So, $\vec{v}_d = \vec{a}\tau \quad \Rightarrow \quad \vec{v}_d = \frac{-e\vec{E}}{m_e}(\tau)$

Where,

$\vec{v}_d$ = Drift velocity of electrons

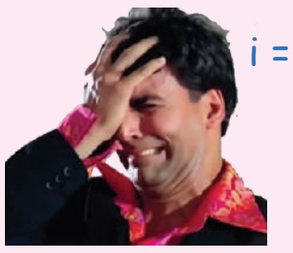
$\vec{E}$ = Electric field applied

m_e = Mass of electron

τ = Average relaxation time

The direction of drift velocity for electrons in a metal is opposite to that of applied field $\vec{E}$.

$$i = V_d enA = \left(\frac{eE}{m}\right)\tau\, enA = \frac{eV}{ml}\tau\, enA$$



$$i = \frac{e^2\tau nvA}{ml} = \frac{v}{\left(\frac{ml}{\tau e^2 nA}\right)} = \frac{V}{R} = \frac{\Delta V}{R}$$

$$E = \frac{V}{l} = \frac{\text{Pot. diff}}{\text{length}}$$

$\Delta V = iR$
Ohm's Law

and

$$i = V_d enA$$

$$\frac{i}{A} = V_d en = \frac{eE}{m}\tau en$$

$$J = \frac{e^2\tau n}{m}E = \sigma E$$

$$\vec{J} = \sigma\vec{E}$$

$$\text{mobility} = \mu = \frac{\text{Drift velocity}}{E.F}$$

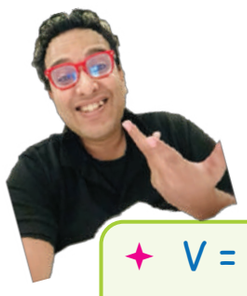
$$\mu = \frac{V_d}{E}$$

$\Delta V = iR$ (ohm's law)

substance which follow ohm's law called ohmic structure.

$$\frac{1}{\rho} = \sigma = \frac{\tau e^2 n}{m} = \text{conductivity}$$

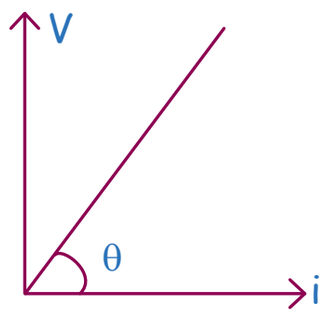
$$R = \frac{\rho l}{A} = \frac{l}{\sigma A}$$



- $V = iR$
- $i = V_d enA$
- $v_d = \frac{eE}{m}\tau$
- $\vec{J} = \sigma\vec{E}$
- $R = \rho\frac{l}{A} = \frac{l}{\sigma A}$ (ρ = resistivity, σ = conductivity)
- $\frac{1}{\rho} = \sigma = \frac{\tau e^2 n}{m}$ = conductivity
- mobility = $\mu = \frac{\text{Drift velocity}}{E.F} = \frac{V_d}{E}$

सवाल आएगा तो इसी BOX से आऐगा।

- Ohm's law $i \propto V$



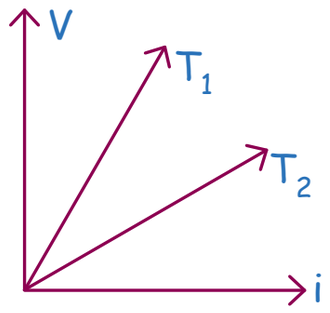
V = iR
y = mn

$i = \frac{V}{R}$ Electric Resistance

$\tan\theta = \frac{V}{i}$ = Resistance

As T↑ ⇒ R↑ ⇒ slope↑

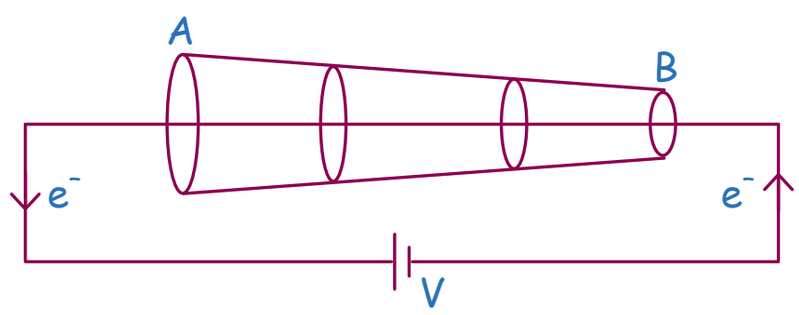
For a given material graph between ΔV & i is plotted at diff temp T_1&T_2



$(Slope)_1 > (Slope)_2$

(T↑, R↑, slope↑) ⇒ $T_1 > T_2$

Q. As we move from right to left A to B analyse the question.



Sol. A to B ⇒ Area of cross section decrease

$i = V_d enA$

1. Current → same
2. Current density = $\frac{i}{A}$ = J↑ (increase)
3. Electric field = E↑ (increase bcz $\vec{J} = \sigma\vec{E}$)
4. Drift velocity V_d↑ (increase bcz $V_d = \frac{i}{enA}$)

TEMP DEPENDENCY OF ρ & R

- $\rho = \rho_0(1 + \alpha\Delta T)$
- $R = R_0(1 + \alpha\Delta T)$
- $R = R_0[1 + \alpha(T - Ti)]$
- R_0 is the resistance at Temp T_1
- $T_1 = 0°C \Rightarrow R_0$ is resistance at 0°C
- For metal/conductor ⇒ $\alpha > 0$ T↑, R↑
- For semi conductor ⇒ $\alpha < 0$ T↑, R↓

Q. Value of resistance at 10° c is 50Ω and at 30°c is 60Ω Find resistance at 50°c

Sol. $R = R_0(1 + \alpha\Delta T)$

$50 = R_0[(1 + \alpha(10 - 0)]$

$60 = R_0[(1 + \alpha(30 - 0)]$

$60 + 600\alpha = 50 + 1500\alpha$

$\alpha = \frac{1}{90}$

$50 = R_0(1 + 1/90 \times 10)$

$R_0 = 45$

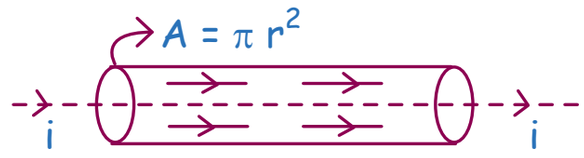
$R_f = R_0(1 + \alpha\Delta T)$

$= 45(1 + 1/90 \times (50 - 0))$

$= 45(1 + 5/9) = \frac{45 \times 14}{9}$

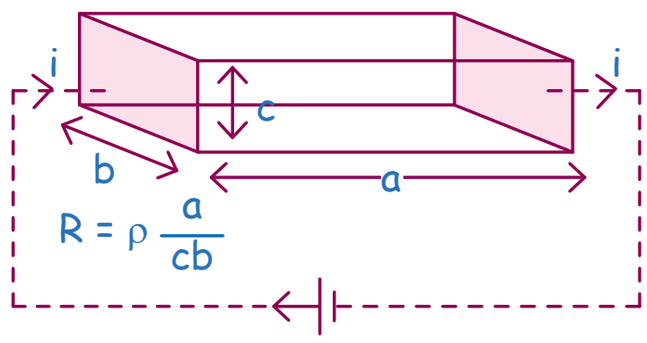
अब in following case में R_{eq} की अच्छे से practice करलो (apply smartly $R = \rho l/A$)

1.



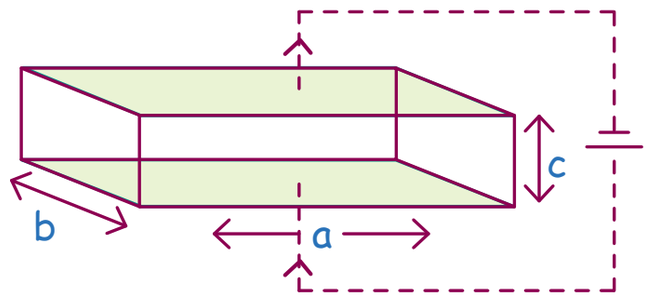
Solid Cylinder $R = \rho \frac{l}{\pi r^2}$

2.



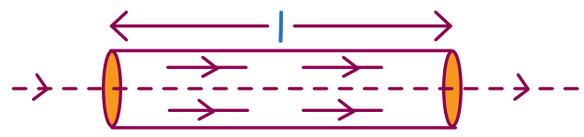
$R = \rho \frac{a}{cb}$

3.



$R = \rho \frac{c}{ab}$

4.



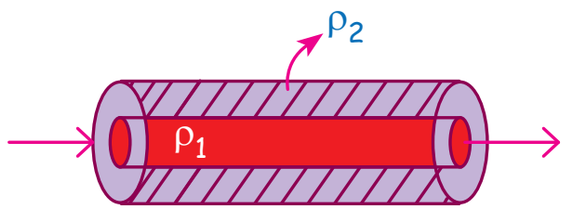
$R = \rho \frac{l}{A} = \rho \frac{l}{\pi r^2}$

5.

$R = \rho \frac{l}{\pi (R_2^2 - R_1^2)}$

(R_1 is inner radius R_2 is outer radius)

6.

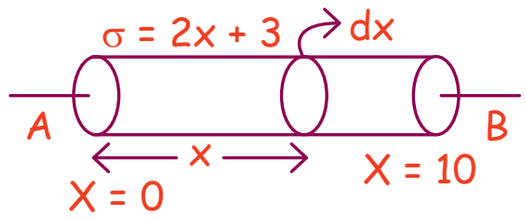


$$R_1 = R \text{ अदर} = \rho_1 \frac{l}{\pi R_1^2}$$

$$R_2 = R \text{ बाहर} = \rho_2 \frac{l}{\pi(R_2^2 - R_1^2)}$$

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

Q. R_{eq} between A & B



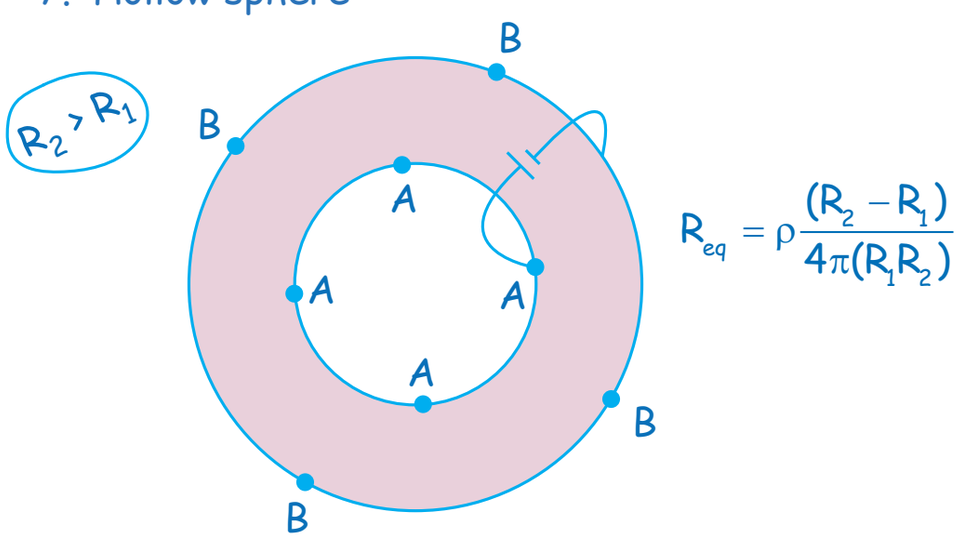
Sol. $= dR = \rho \frac{dx}{\pi r^2} = \frac{l}{\sigma} \frac{dx}{\pi r^2}$

$$\int dR = \int \frac{1}{2x+3} \times \frac{dx}{\pi r^2}$$

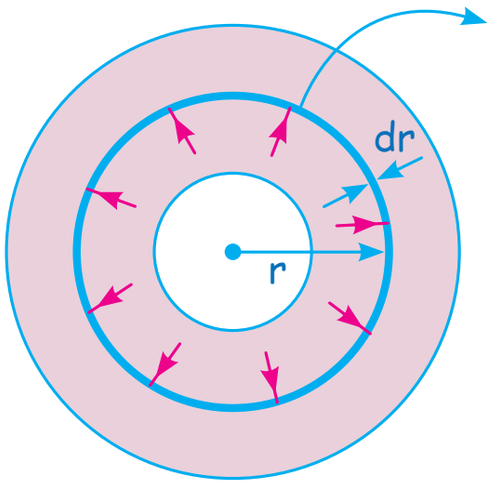
$$R_{eq} = \frac{1}{\pi r^2} \int_0^{10} \frac{dx}{2x+3}$$

Ans: $R = \frac{1}{\pi r^2 \times 2} \ln\left(\frac{23}{3}\right)$

7. Hollow sphere



$$R_{eq} = \rho \frac{(R_2 - R_1)}{4\pi(R_1 R_2)}$$



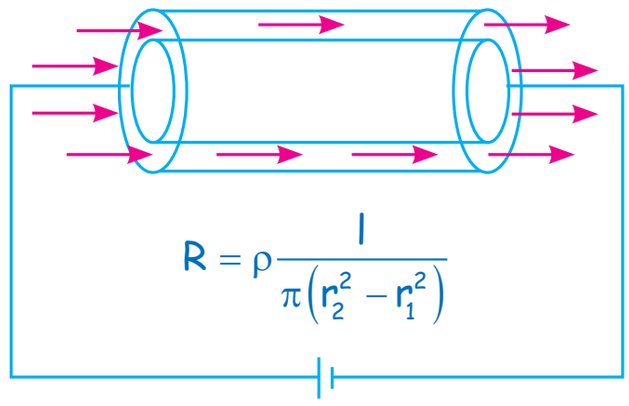
$$\int dR = \int_{R_1}^{R_2} \rho \frac{dr}{4\pi r^2}$$

$$R_{net} = \frac{\rho}{4\pi}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$R_{net} = \frac{\tilde{n}(R_2 - R_1)}{4 R_1 R_2}$$

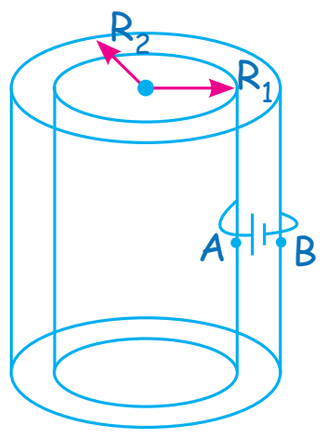
8. Hollow cylinder

(a)



$$R = \rho \frac{l}{\pi\left(r_2^2 - r_1^2\right)}$$

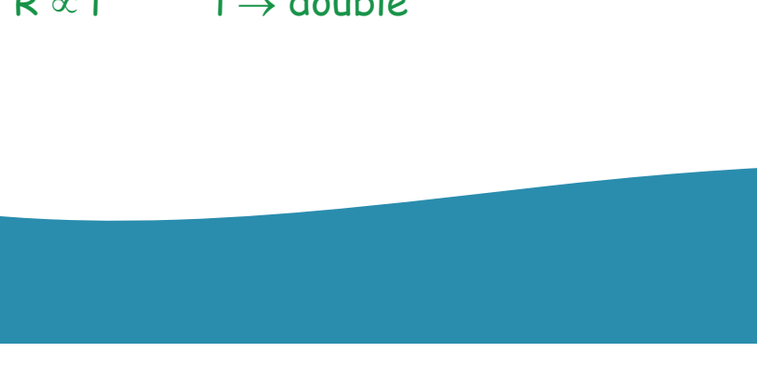
(b) $R_2 > R_1$



$$\int dR = \int_{R_1}^{R_2} \rho \frac{dr}{2\pi r l}$$

$$\boxed{R_{eq} = \frac{\rho}{2\pi l} \ln\left(\frac{R_2}{R_1}\right)}$$

9.



$$R = \rho \frac{l}{\pi . ab}$$

Q. If length of resistance is increase by 5% Find % increase in resistance.

Sol. $R = \rho \frac{l}{A} = \rho \frac{l^2}{Al}$ $(V \to \text{const})$

$R \propto l^2$ $\frac{\Delta l}{l} \times 100 = 5$

$$\frac{\Delta R}{R} = \frac{2\Delta l}{l}$$

$$\frac{\Delta R}{R} \times 100 = 2\left(\frac{\Delta l \times 100}{l}\right)$$

$= 2 \times 5 = 10\%$

Q. A cylindrical wire is increased double its original length the % increase in the Resistance of wire

Sol. $R = \frac{\rho l}{A} = \frac{\rho l^2}{Al} = \frac{2l^2}{\text{vol}^n}$

$R \propto l^2$ $l \to$ double

$R \rightarrow 4$ times

$$\% \frac{\Delta R}{R} = \frac{R_f - Ri}{R} \times 100$$

Ans. 300%

Q.

Find the condition for which this combination R_{eq} is independent on the Temp

Sol. $Ri = R_1 + R_2 = \rho_1 \frac{l}{A} + \rho_2 \frac{l}{A}$

$R_f = (R_1 \text{नया}) + (R_2 \text{नया}) = R_1(1 + \alpha_1 \Delta T) + R_2(1 + \alpha_2 \Delta T)$

$R_i = R_f$

$$\rho_1 \frac{l}{A} + \rho_2 \frac{l}{A} = \rho_1 \frac{l}{A}(1 + \alpha_1 \Delta T) + \rho_2 \frac{l}{A}(1 + \alpha_2 \Delta T)$$

Solve and get $\rho_1 \alpha_1 + \rho_2 \alpha_2 = 0$

(अब यह मत सोचना ऐसा कैसे हुआ इसका मतलब है कोई एक α negative है)

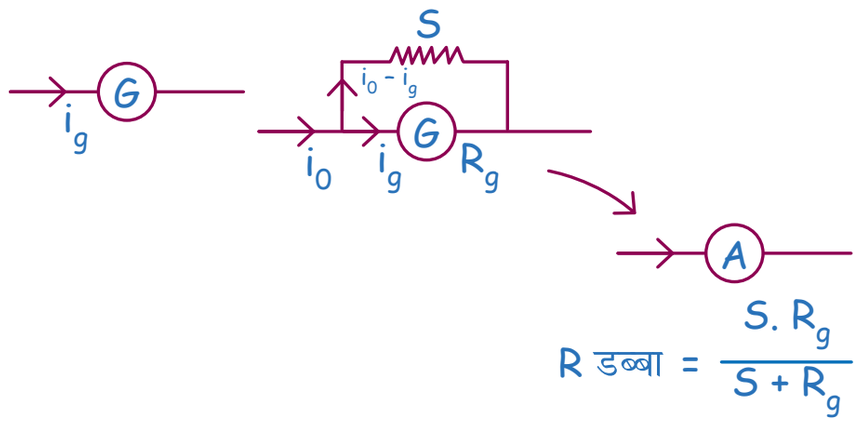
CONVERSION OF GALVANOMETER INTO AMMETER/VOLTMETER.

तीनो दिखने में एक जैसे ही होते है बस labelling का अंतर है यकीन नही आता ऊपर के image को ठीक से देखा।

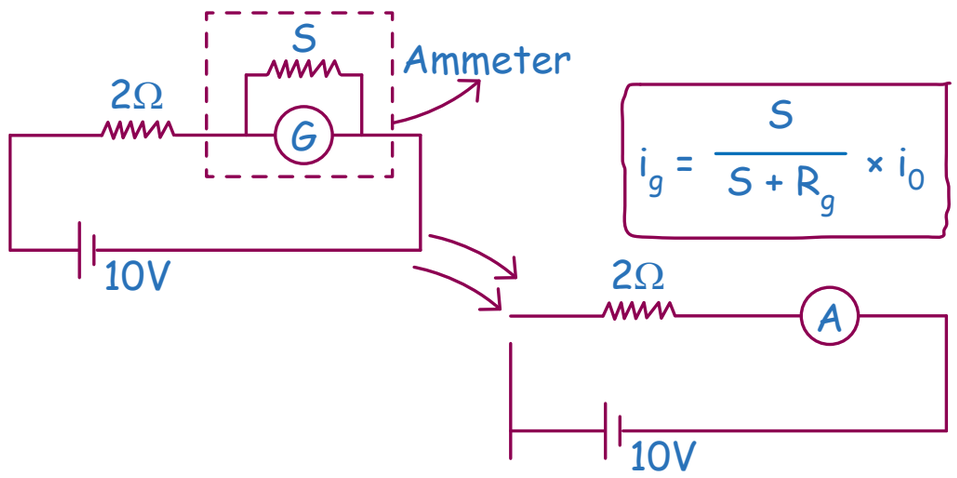
बस इतना याद रखो galvanometer के parallel में छोटा सा resistance लगाने पर यह ammeter बन जाता है और galvaometer के बाजू में बहुत बड़ा resistance लगाने पर ये voltmeter बन जाता है।

Ideal ammeter का resistance zero or ideal voltmeter का resistance infinity होता है।

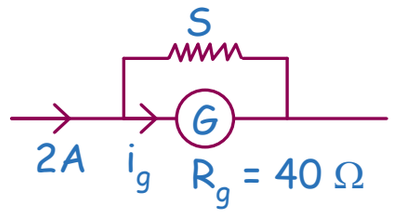
Conversion of Galvanometer into Ammeter



R डब्बा $= \frac{S.R_g}{S + R_g}$



Q. A Galvanometer of resistance 40Ω can read max current of 50mA. Find the resistance require to that it converted into ammeter which can measure the current upto 2A.



Sol. $i_g = \frac{S}{S + G} \times i \text{ total}$

$50 \times 10^{-3} = \frac{S}{S + 40} \times 2$

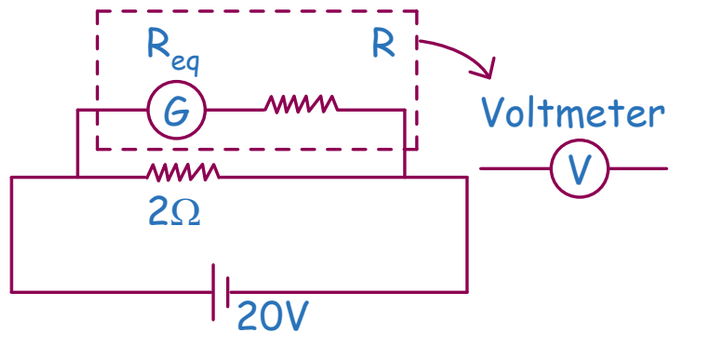
$50 (S + 40) = 2000S$

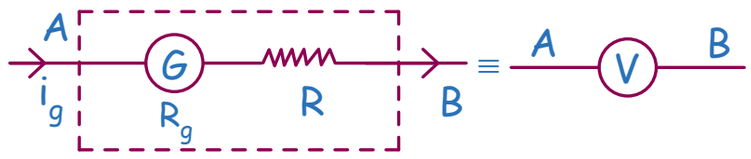
$50S + 2000 = 2000S$

$2000 = 1950S$

$S = \frac{2000}{1950}$

Conversion of Galvanometer into Voltmeter



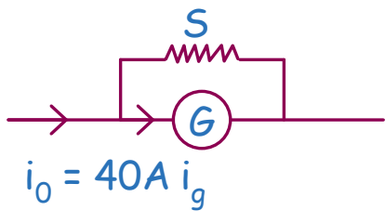


$V_{AB} = i_g(R + R_g)$ (ideally V Resist infinity)

Q. A galvanometer has coil of resistance 40Ω showing full scale deflection of 80mA what resistance should be added and how so that

1. It become Ammeter of range 40A

Sol.



$i_0 = 40A\ i_g$

$$i = \frac{S}{S+g} \times i_0$$

$$80 \times 10^{-3} = \frac{S}{S+40} \times 40$$

$$80S + 3200 = 40000\ 'S'$$

$$S = \frac{3200}{39920}$$

2. It become voltmeter of range 40 volt

$$V_{AB} = i_g(R_g + R)$$

$$40 = 80 \times 10^{-3}(40 + R)$$

$$R = 460\Omega$$

Now few important questions practice them sincerly

Q. In following case find r_{eq} & ρ_{eq} if rods A & B are connected in series of length $3l_0$.

Rod A: $\rho_0, l_0, 3\alpha, A$

Rod B $\Rightarrow 2\rho_0, 2l_0, 2\alpha, A$

Sol.

$$R_1 = \rho_0(1 + 3\alpha\Delta T)\frac{l_0}{A}$$

at only temp

$$R_2 = 2\rho_0(1 + 2\alpha\Delta T)\frac{2l_0}{A}$$

$$R_{eq} = R_1 + R_2 = \rho_0 \frac{l}{A}(1 + 3\alpha\Delta T) + 4\rho_0\frac{l}{A}(1 + 2\alpha\Delta T)$$

$$\rho_{eq}(1 + \alpha_{eq}\Delta T)\frac{3l_0}{A} = R_{eq} = \rho_0\frac{l_0}{A}(1 + 3\alpha\Delta T) + 4\rho_0\frac{l}{A}(1 + 2\alpha\Delta T)$$

$$3\rho_{eq}(1 + \alpha_{eq}\Delta T) = \rho_0 + 3\alpha\rho_0\Delta T + 4\rho_0 + 8\alpha\rho_0\alpha\Delta T$$

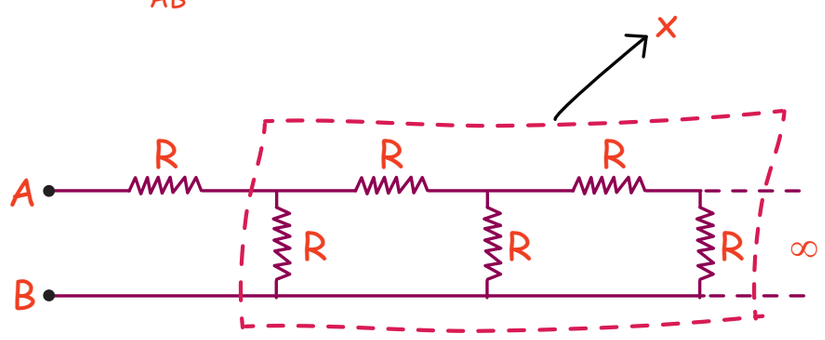
$$3\rho_{eq} + (3\rho_{eq}\alpha_{eq})\Delta T = 5\rho_0 + 11\alpha\rho_0\Delta T$$

$$3\rho_{eq} = 5\rho_0 \quad \boxed{\rho_{eq} = 5/3\rho_0}$$

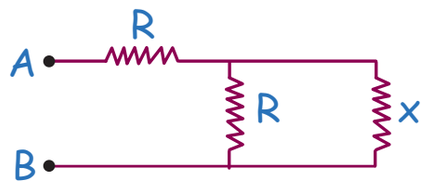
$$3\rho_{eq}\,\alpha_{eq} = 11\alpha\rho_0 \quad 5\rho_0\,\alpha_{eq} = 11\alpha\rho_0 \quad \boxed{\alpha_{eq} = \frac{11}{5}\alpha}$$

✦ ∞ ladder question

Q. Find R_{AB} ?



Sol.



Circuit को शुरु मे कितना मिटा दू की उसकी शक्ल सूरत वैसी की वैसी ही रहे

$$R_{AB} = x$$

$$R_{AB} = x = R + \frac{Rx}{R+x}$$

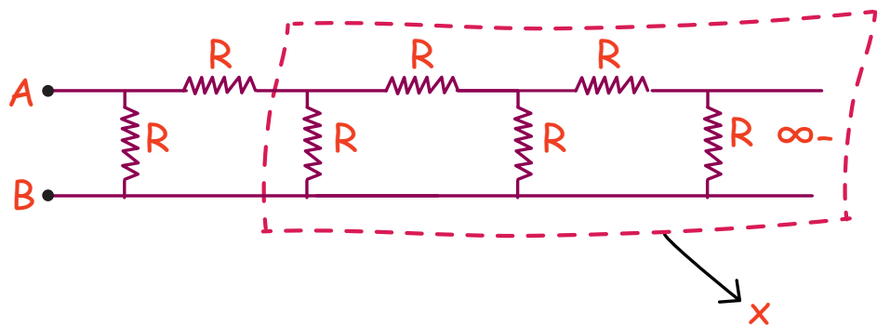
$$x = \frac{R(R+x) + Rx}{R+x}$$

$$xR + x^2 = R^2 + Rx + Rx$$

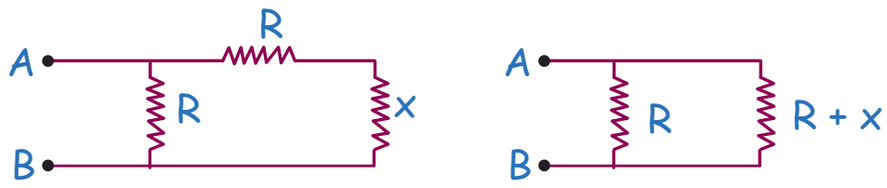
$$x^2 - Rx - R^2 = 0$$

$$x = \text{solve \& get, } x = \frac{R + \sqrt{5}R}{2}$$

Q. R_{AB} = ?



Sol.



$$R_{AB} = \frac{R(R+x)}{R+R+x} = x = \frac{R^2 + Rx}{2R + x} = x$$

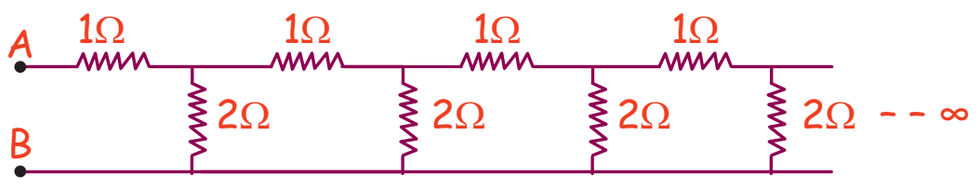
$$R^2 + Rx = 2Rx + x^2$$

$$x^2 - Rx - R^2 = 0$$

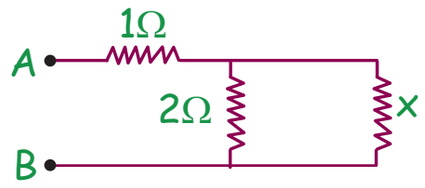
$$x = \frac{-R + \sqrt{R^2 + 4R^2}}{2}$$

$$x = R\left(\frac{\sqrt{5} - 1}{2}\right)$$

Q. R_{AB} = ?



Sol.



$$R_{AB} = x = 1 + \frac{2x}{x+2}$$

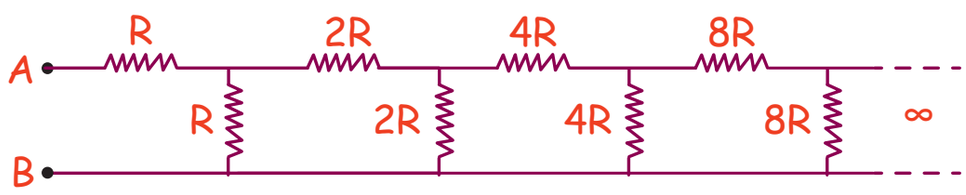
$$x - 1 = \frac{2x}{x+2}$$

$$(x-1)(x+2) = 2x$$

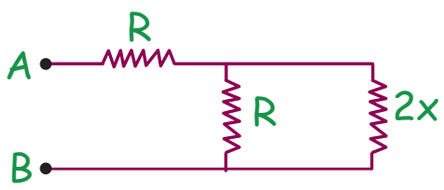
$$x^2 + 2x - x - 2 = 2x$$

$$x = \frac{1 - \sqrt{1+8}}{2} = 2$$

Q. Find R_{AB} = ?



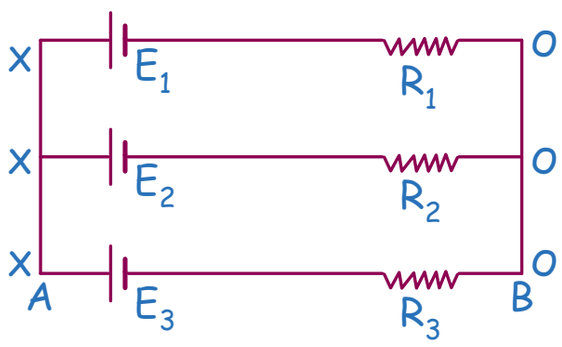
Sol.



$$R_{AB} = x = \frac{R\,2x}{R+2x} + R$$

Solve & get

Grouping of Cell

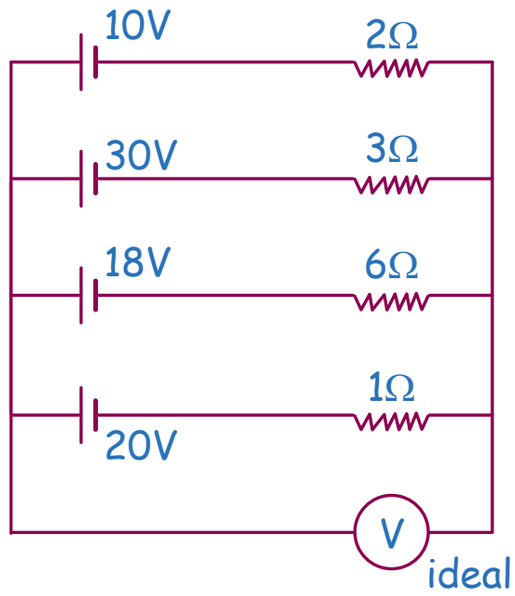


#SKC

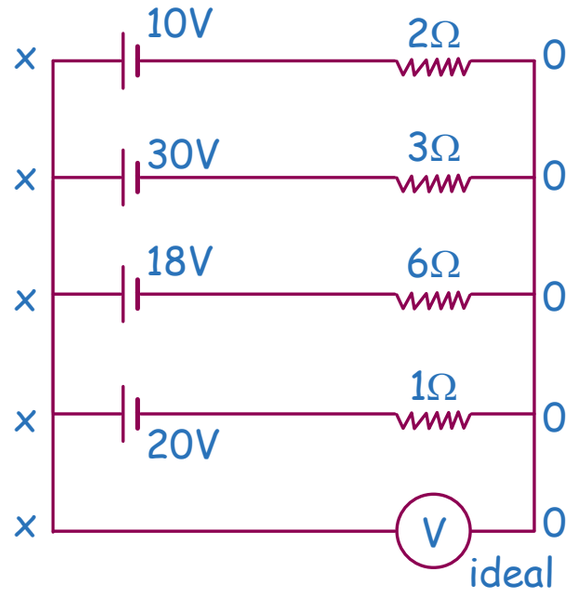
$$x = V_{AB} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2} + \frac{E_3}{r_3}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}}$$

अगर इस तरह के सवाल में direct x पुछे तो बिंदास SKC लगाओ।

Q. Find reading of ideal voltmeter.



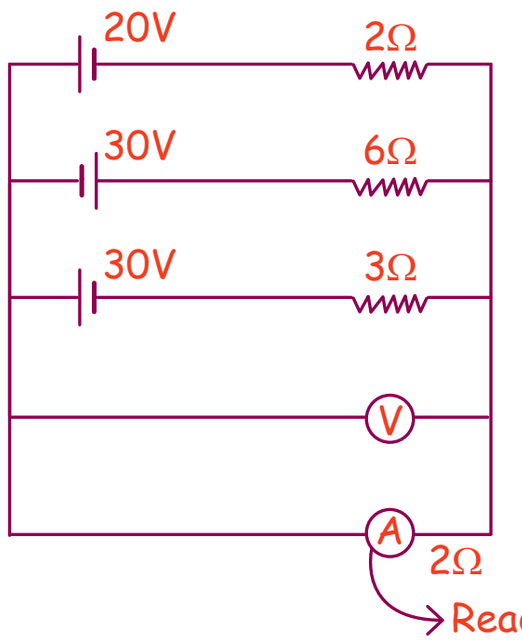
Sol.



$$x = \frac{10/2 + 30/3 + 18/6 + 20/1}{1/2 + 1/3 + 1/6 + 1/1} = \frac{5 + 10 + 3 + 20}{2}$$

$$x = V_{AB} = 19$$

SSSQ. Find volt meter and ammeter reading

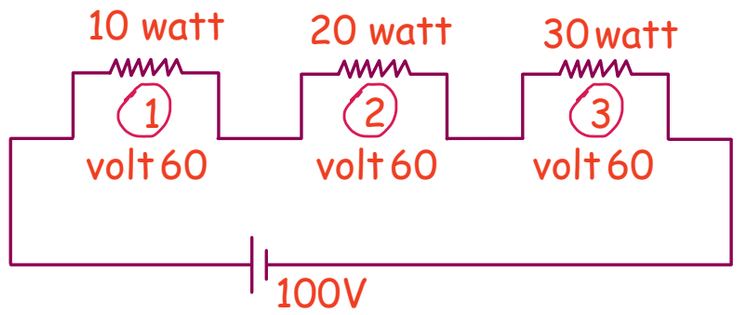


Sol. $x = \frac{20/2 - 30/6 + 30/3 + 0/2}{1/2 + 1/6 + 1/3 + 1/2} = 10$

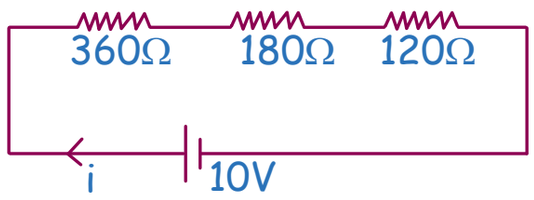
$= 10$ (V) (Voltmeter Reading)

$$i = \frac{x - 0}{2} = \frac{10 - 0}{2} = 5 = \text{Ammeter reading}$$

Q. Compare brighter of bulbs.



Sol. $R = \frac{V^2}{P} = \frac{60 \times 60}{10} = 360$



$B_1 > B_2 > B_3$

$$i = \frac{10}{360 + 180 + 120}$$

Q. Find the total average momentum of electrons in a straight wire of length $l = 1000$ m carrying current $I = 704$ A.

Sol. Let n be no. of electrons per unit volume.

No. of electrons in length l

$N = nSl$ (S is cross-sectional area)

Momentum of one electron = mv_d

Total momentum $P = (nSl)mv_d$

As $v_d = \frac{I}{neS}$

$$P = (nSl)m\frac{I}{(neS)} = \frac{mlI}{e}$$

On substituting numerical values, we get

$P = 4\mu$ Ns

Q. The temperature coefficient of resistivity α is given by $\alpha = \left(\frac{1}{\rho}\right)\frac{d\rho}{dT}$, where ρ is the resistivity at temperature T. Assume that α is not constant and follows the relation $\alpha = -\frac{a}{T}$, where T is the absolute temperature and a is a constant. Show that the resistivity ρ is given by $\rho = \frac{b}{T^a}$, where b is another constant.

Sol. $\alpha = \frac{1}{\rho}\frac{d\rho}{dT} \Rightarrow \frac{d\rho}{\rho} = \alpha dT = -a\frac{dT}{T}$

Let $\rho = \rho_0$ at $T = T_0$, then

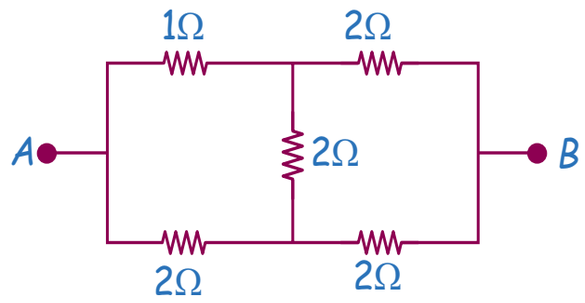
$$\int_{\rho_0}^{\rho}\frac{d\rho}{\rho} = -a\int_{T_0}^{T}\frac{dT}{T}$$

$$\Rightarrow \log_e\left(\frac{\rho}{\rho_0}\right) = -a\log_e\left(\frac{T}{T_0}\right) = \log_e\left(\frac{T_0}{T}\right)^a$$

$$\Rightarrow \rho = (\rho_0 T_0^a)\frac{1}{T^a} = \frac{b}{T^a}$$

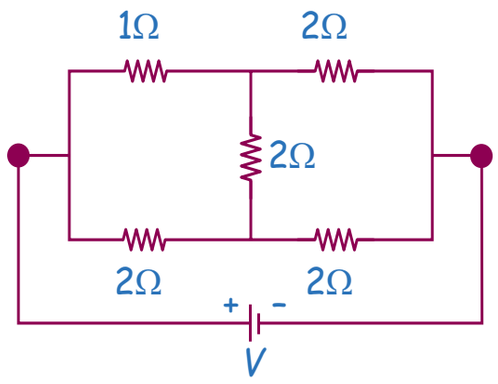
Here, $b = \rho_0 T_0^a$

Q. Find the equivalent resistance across terminals A and B.

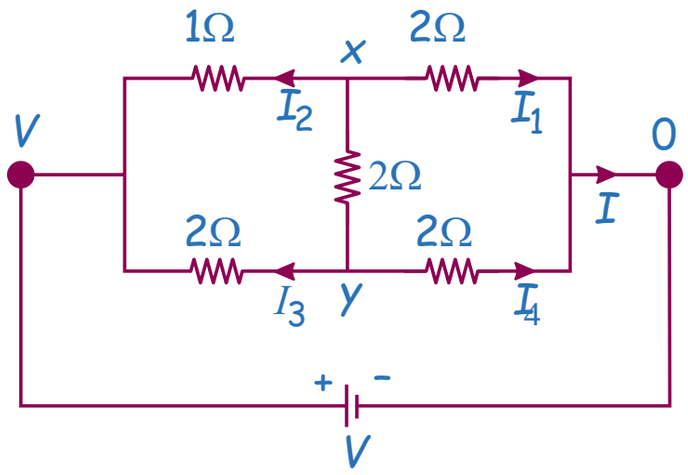


Sol. This is a case of unbalanced Wheatstone bridge.

Step 1: Connect a battery across the terminal.



Step 2: Mark the voltages of nodes.



Step 3: Calculate $R_{eq} = \frac{V}{I}$

Apply KCL at node 'x'

$$\Rightarrow \frac{x-V}{1} + \frac{x-0}{2} + \frac{x-y}{2} = 0$$

$\Rightarrow 2x - 2V + x + x - y = 0 \quad \Rightarrow 4x - 2V = y \quad \ldots (i)$

Apply KCL at node 'y'

$$\frac{y-x}{2} + \frac{y-V}{2} + \frac{y}{2} = 0 \qquad \Rightarrow 3y - V = x \quad \ldots (ii)$$

Solve equations (i) and (ii),

$$x = \frac{7V}{11}, y = \frac{6V}{11}$$

Now calculate: $I_1 = \frac{x-0}{2} = \frac{7V}{22}$ and $I_2 = \frac{y}{2} = \frac{6V}{22}$

So, equivalent resistance

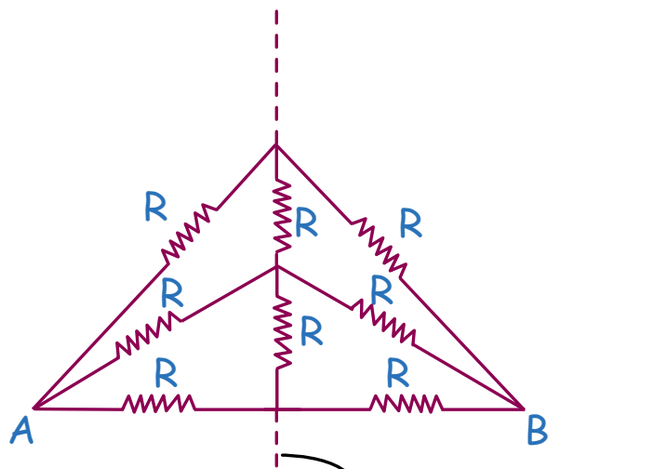
$$R_{eq} = \frac{V}{I} = \frac{V}{I_1 + I_2} = \frac{V}{\frac{7V}{22} + \frac{6V}{22}} = \frac{V}{\frac{13V}{22}} \Rightarrow R_{eq} = \frac{22}{13}\Omega$$

SYMMETRY (Not much important for jee mains)

- Perpendicular Bisector symm
- Folding symm
- input output symm

Perpendicular Bisector symmetry

example



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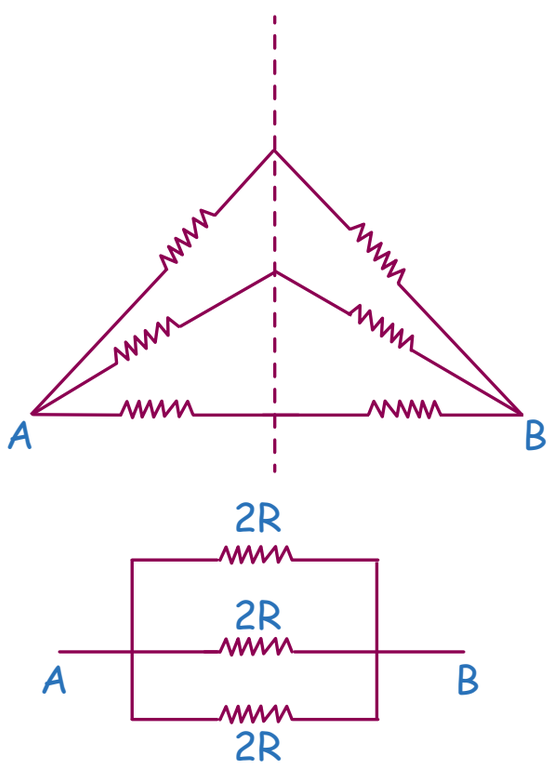
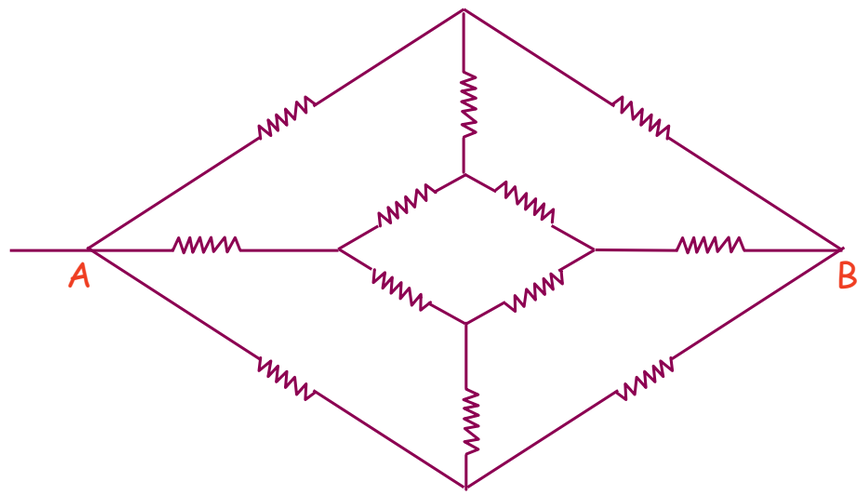


#SKC

A को B से connect करो और AB के $\perp^{ar}$ Bisector लो

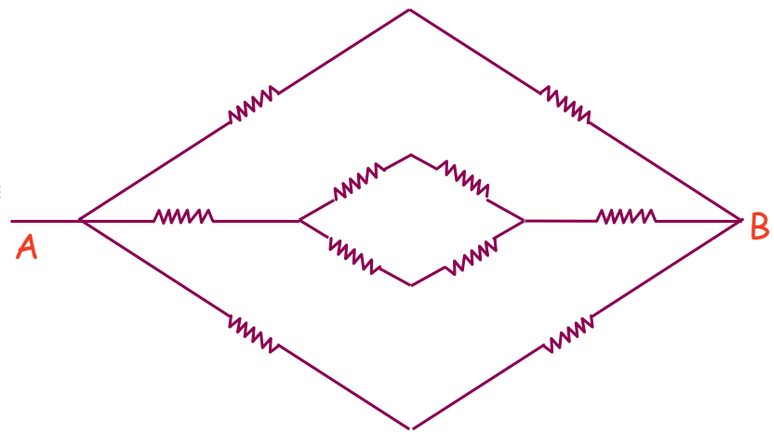
उसके आजू-बाजू अगर circuit mirror image है तो bisector line के resistance उड़ा दो

Q. All resisters have same value 'R'. Find R_{AB}

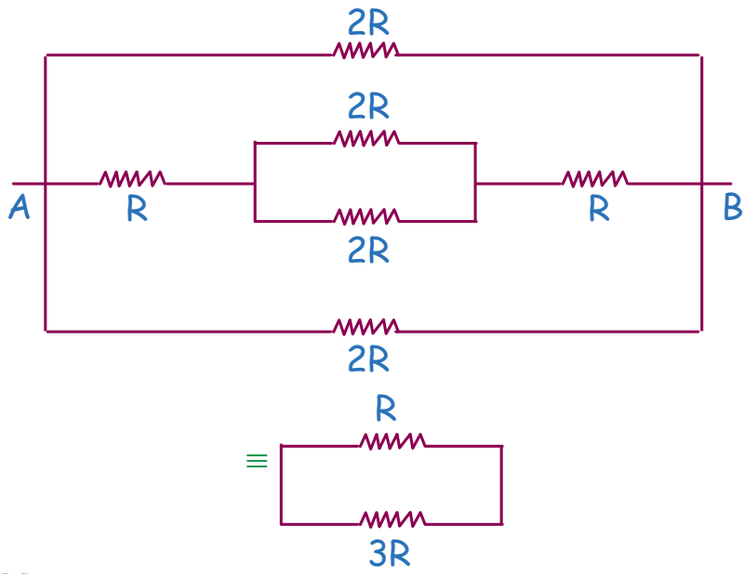


Sol.

≡



All resistance have same 'R'



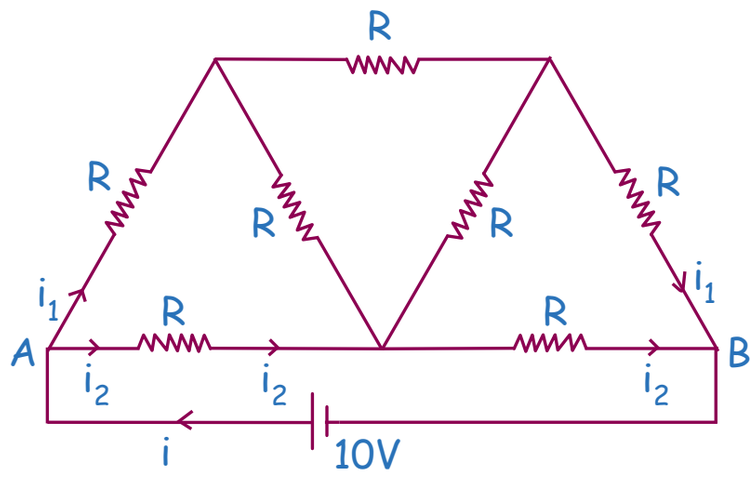
$$\frac{3R}{4} = R_{AB}$$

✦ Input output symmetry

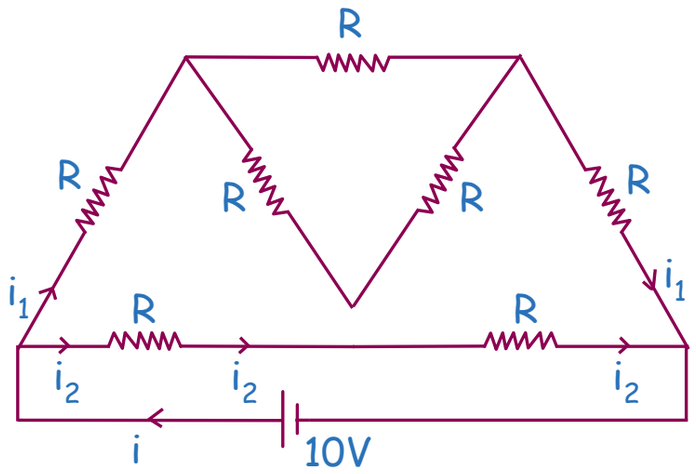
If current has similar path in entering side to exit & vice versa then circuit is said to be input output symmetry.

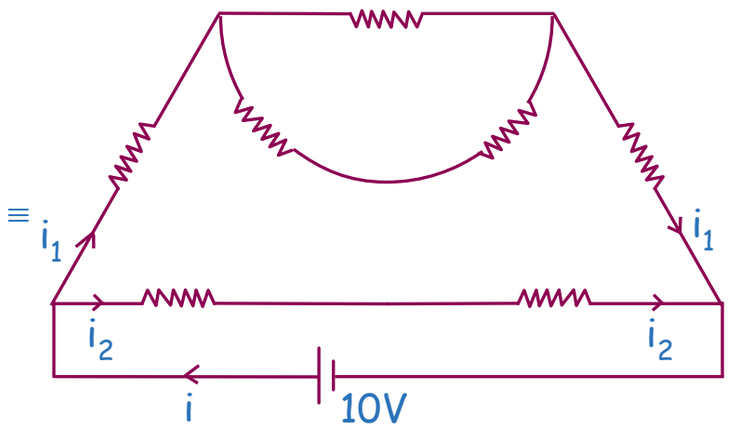
Under such condition for entry side & exit side are same

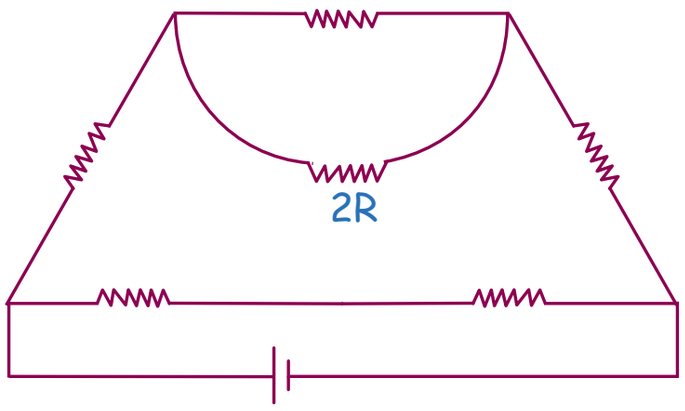
Q. Each resistance = R, Find R_{AB}

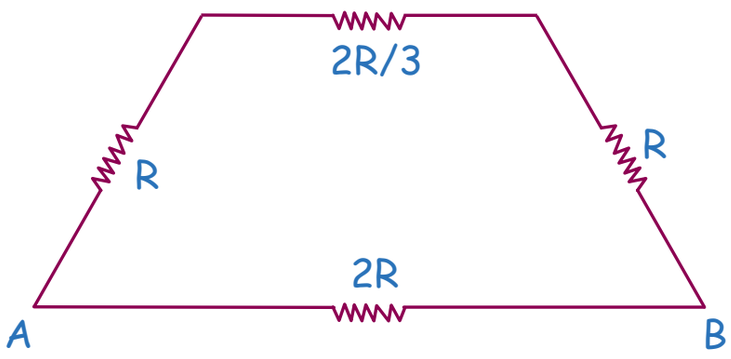


Sol.





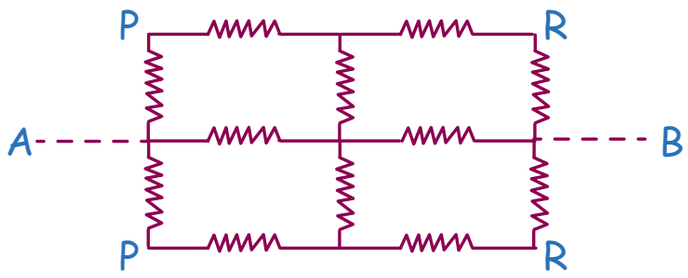




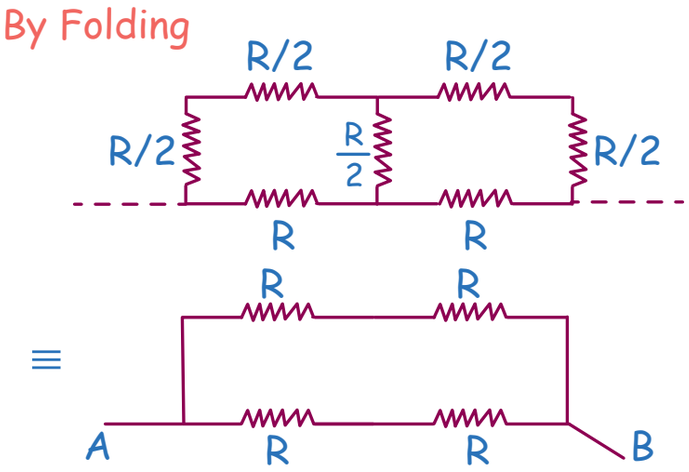
Folding Symmetry

#SKC
अगर AB line के उपर नीचे circuit ek जैसा हो तो नीचे वाले को उपर वाले पर fold करदो मतलब ऊपर के सारे resistance आधे करदा

Q. Each resistance = R, Find R_{AB}

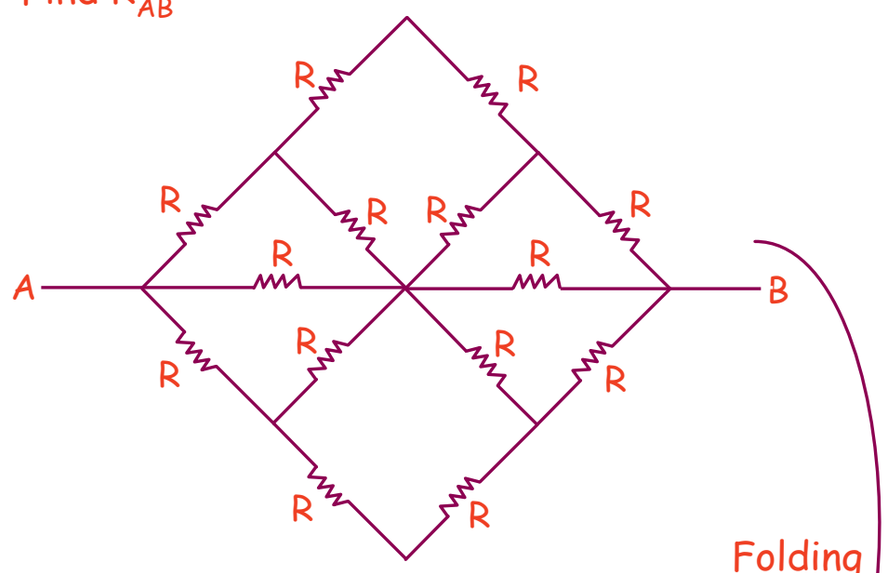


By Folding

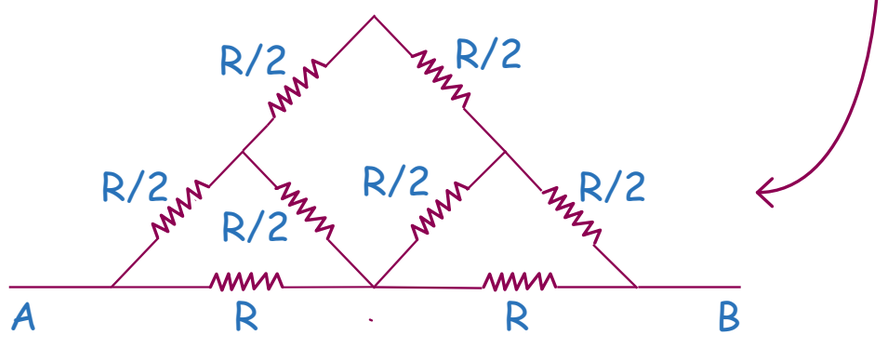


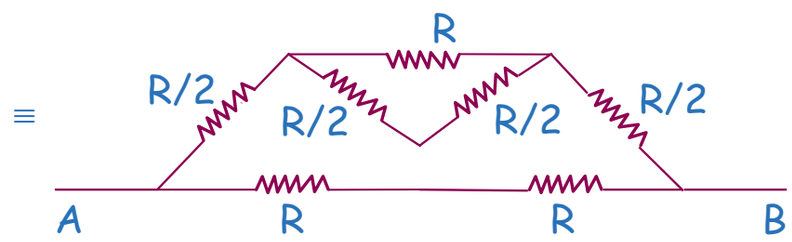
$R_{AB} = R$

Q. Find R_{AB}



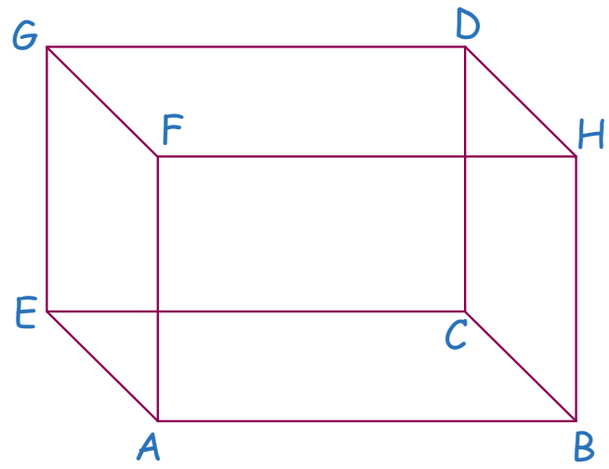
Sol.





Now you can solve.

✦ Cube each of length l, Resistance R(each)



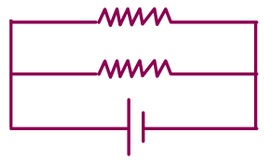
$\frac{7R}{12}$ · $\frac{3R}{4}$ · $\frac{5R}{6}$

R_{AB} R_{AC} R_{AD}

पास-पास थोडा-दूर दूर-दूर

✦ If two appliances with rating (W_1, v)& (W_1, v) are connected to V.

1. In Parallel



Total power dissipated = $\omega_1 + \omega_2$

2. In series

Total power dissipated = ω_{net}

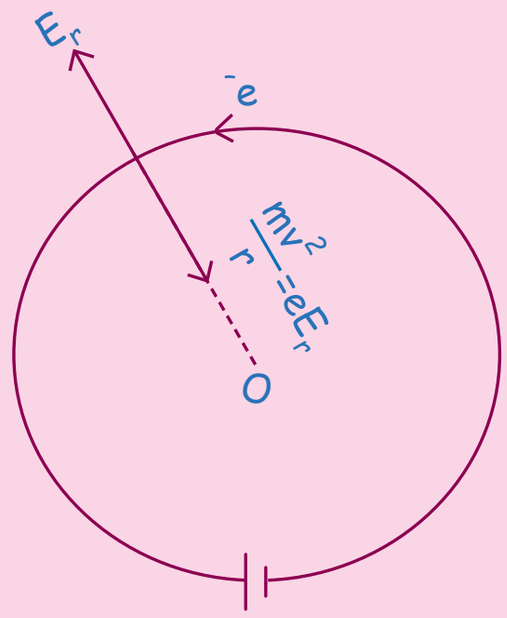
$$\frac{1}{\omega_{net}} = \frac{1}{\omega_1} + \frac{1}{\omega_2}$$

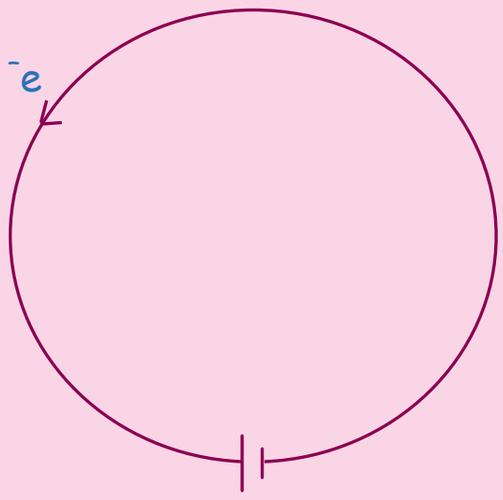
Q. A wire is in a circular shape connected to a battery as shown in figure. Find value of radial electric field.

$eE_t = \frac{mv_d^2}{r}$

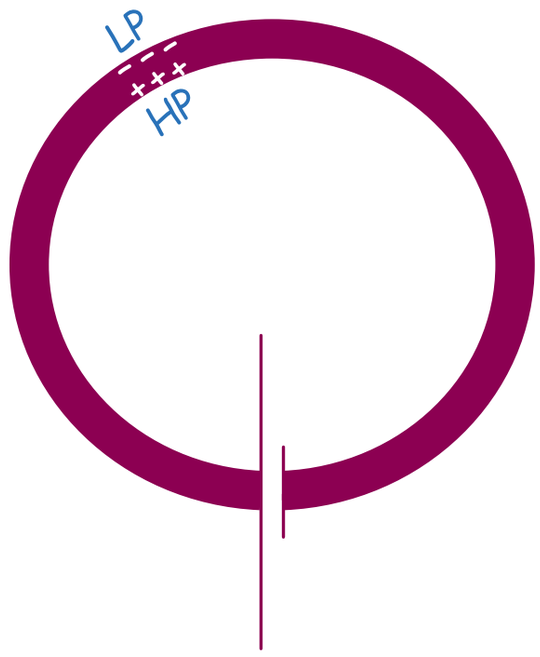
↓ Very law value

(अक्सर neglect कर देते है)

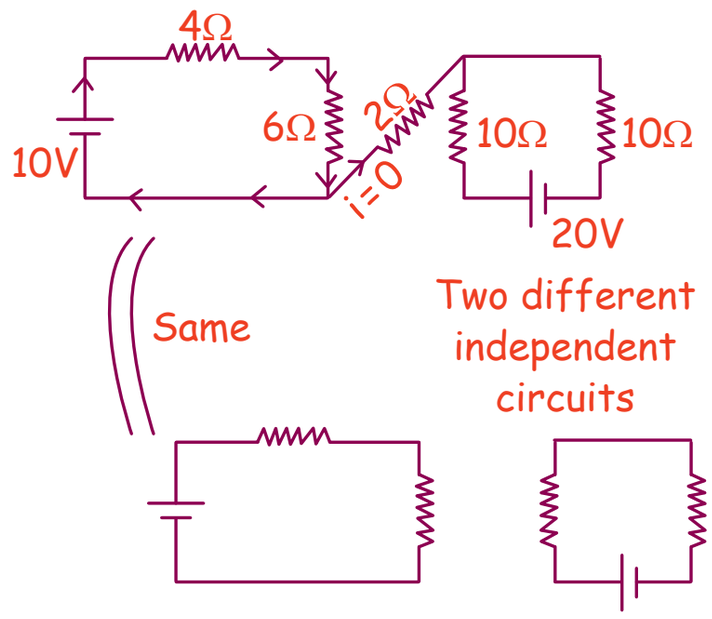




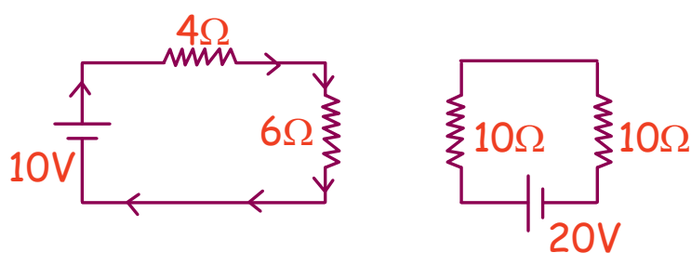
#SKC
यह ध्यान से देखना Current किसकी वजह से आया? e^- की वजह या +ve charge के motion की वजह से



Q.



Now solve and get

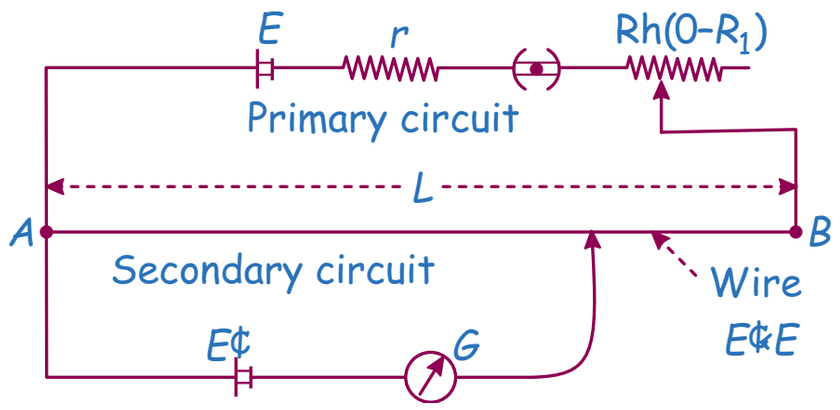


POTENTIOMETER (Not in Jee Mains 2025)

Working Principle of Potentiometer

Any unknown potential difference is balanced on a known potential difference which is uniformly distributed over entire length of potentiometer wire. This process is named as zero deflection or null deflection method.

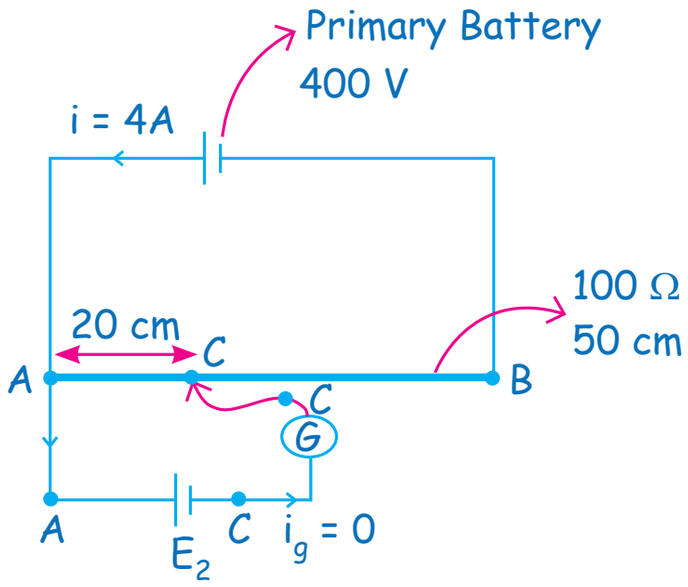
Circuit of Potentiometer



Primary circuit contains constant source of voltage and a rheostat (a resistance box).

Secondary, unknown or galvanometer circuit contains components with unknown parameters.

Q. Find emf of the battery if galvanometer show null deflection at C.



V_{AB} = 400 V

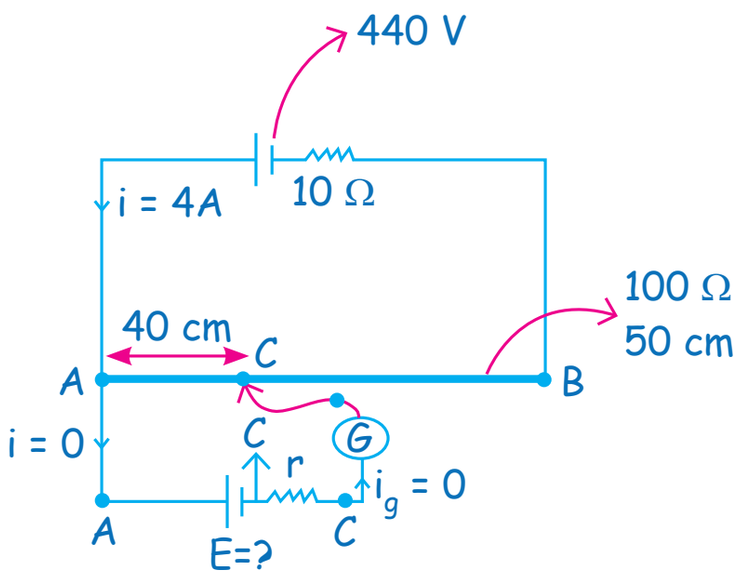
50 cm ⟶ 400 V

1 cm ⟶ $\frac{400}{50}$

20 cm ⟶ $\frac{400}{50}$ × 20

= 160 = V_{AC} = E_2

Q. Find emf of the battery if galvanometer show null deflection at C.

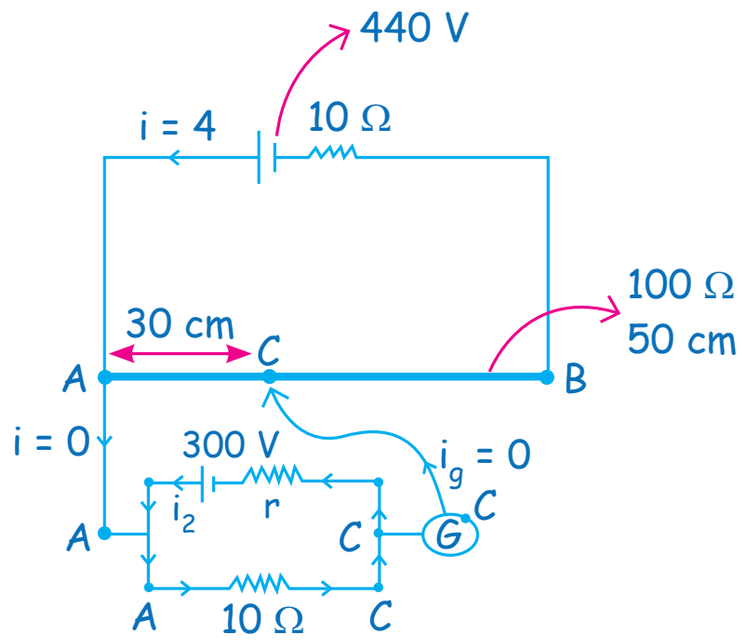


V_{AB} = 400 V

50 cm ⟶ 400 V

40 cm ⟶ $\frac{400}{50}$ × 40 = 320 V

Q. Find internal resistance of the battery if galvanometer show null deflection at C.



$i_2 = \frac{300}{10 + r}$

V_{AB} = 400

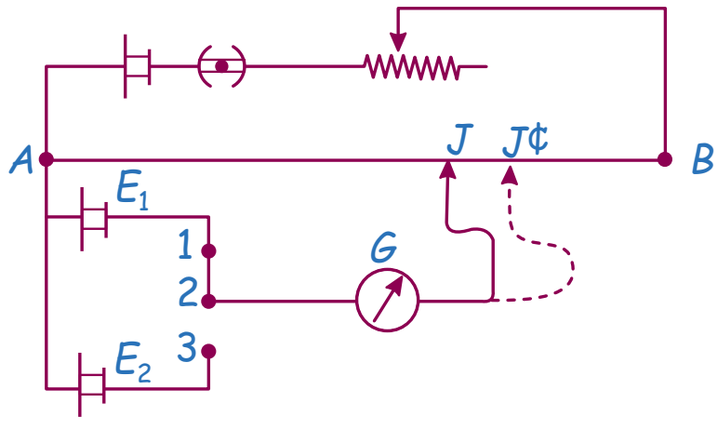
$V_{AC} = \frac{400}{50} \times 30 = 240$

$V_{AC} = \frac{300}{10 + r} \times 10$

$240 = \frac{3000}{10 + r}$

r = 2.5 Ω

☆ Comparison of emf of two cells



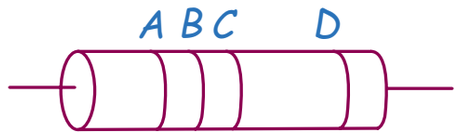
Plug only in (1– 2): Balance length $AJ = \ell_1$

Plug only in (2 – 3): Balance length $AJ' = \ell_2$

$E_1 = x\ell_1$ and $E_2 = x\ell_2$

$\Rightarrow \frac{E_1}{E_2} = \frac{\ell_1}{\ell_2}$

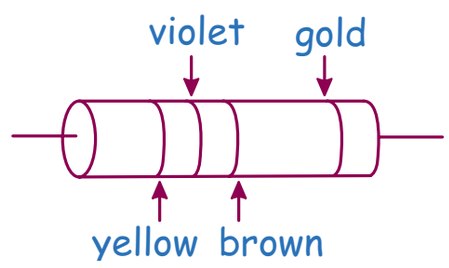
COLOUR CODE FOR CARBON RESISTORS (Removed from Mains 2025 and in Advance also)



	Strip A	Strip B	Strip C	Strip D
Colour	(digit 1)	(digit 2)	(Multiplier)	(Tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Grey	8	8	10^8	
White	9	9	10^9	
Gold	-	-	10^{-1}	±5%
Silver	-	-	10^{-2}	±10%
No Colour	-	-	-	±20%

- Aid to memory **BBROY** of **G**reat **B**ritain does a **V**ery **G**ood **W**ork.

Q. What is the resistance of the following resistor?



Sol. Number for yellow is 4. Number for violet is 7.

Brown colour gives multiplier 10^1, Gold gives a tolerance of ± 5%

So, resistance of resistor is

$47 \times 10^1\ \Omega \pm 5\% = (470\ \pm 5\%)\ \Omega$

यार मेरा वस चले तो
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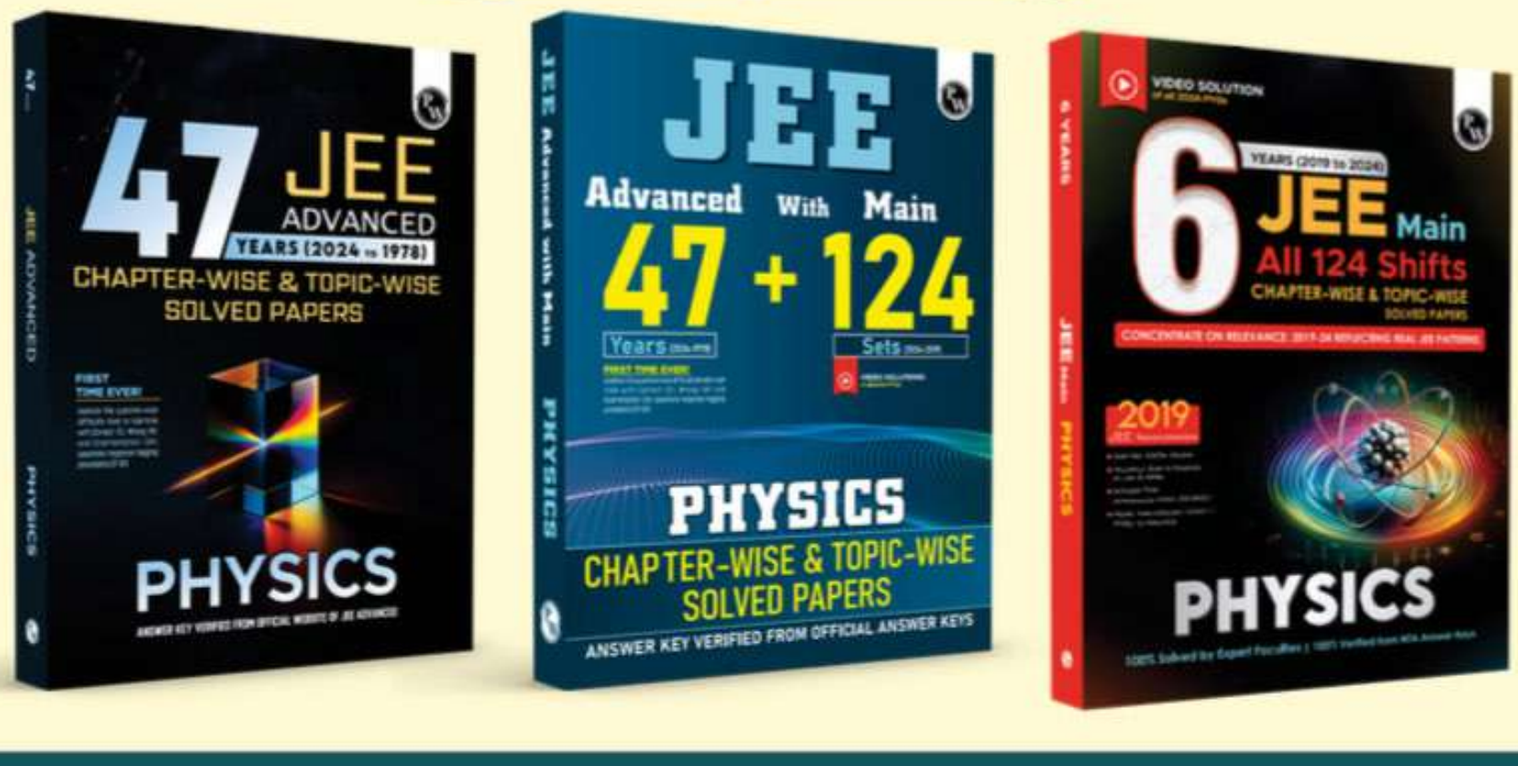
About the Author

Saleem Ahmed, an alumnus of **NIT Trichy** with a **B.Tech in Electronics and Communication Engineering (ECE),** is a highly respected Physics educator with experience of **12+ Years** known for his **engaging teaching style** and **student-centric approach.**

With over 8 **years of experience** as a **Senior and Star Faculty** at **Allen Career Institute, Kota,** he has **mentored lakhs of students,** including many with **top ranks under 100 and under 50** in JEE. Currently, he is a core member of **Physics Wallah,** continuing to guide students with **conceptual clarity** and **problem-solving expertise.**

Affectionately called **"Saleem Bhaiya",** his classes focus on **building concepts from basic to advanced,** helping students unlock their potential. His **17-hour and 19-hour marathon sessions** on the **JEE Wallah YouTube channel** reflect his dedication to student success. Saleem Ahmed's commitment has left a lasting impact on JEE aspirants across the country.

Other Helpful Books



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