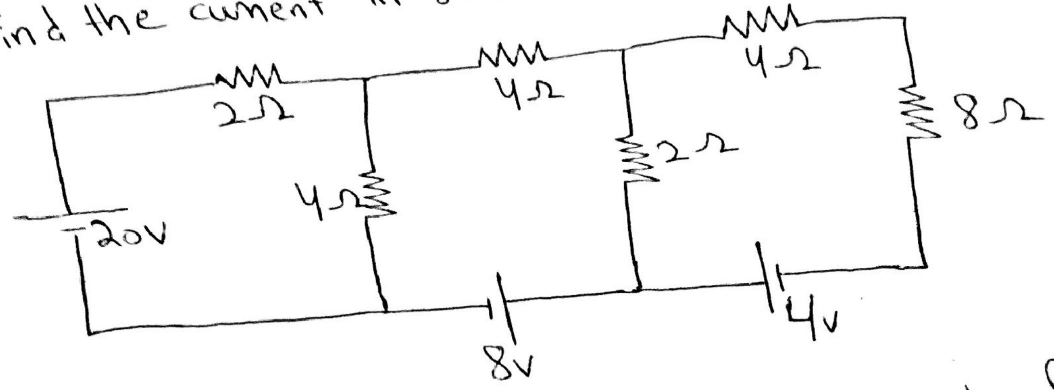
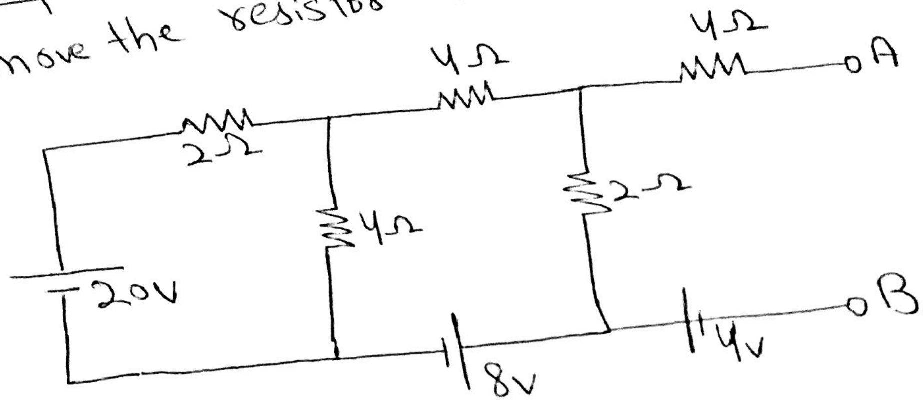
## Norton's Theorem:-

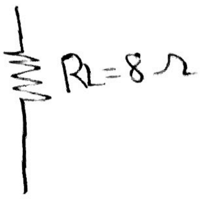
Find the current in 8 Ω resistor using Norton's Theorem.



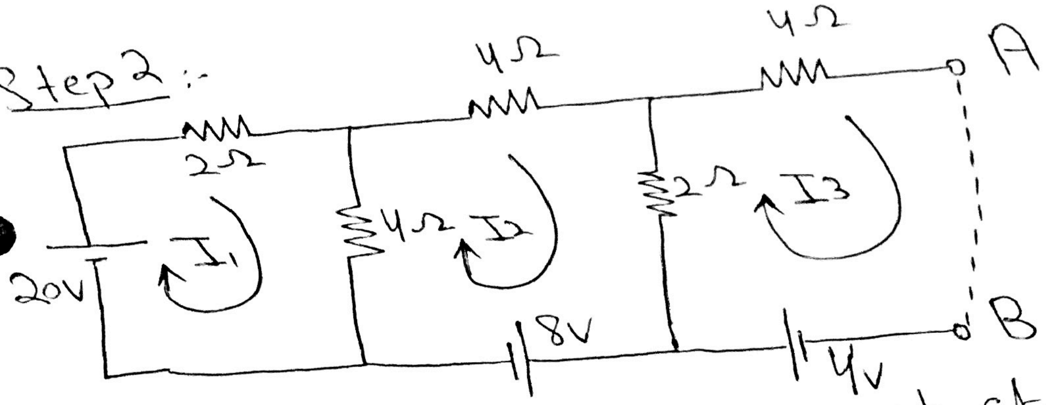

Step No 1:-

- Remove the resistor in which you want to find the current:-




Step 2:-




→ Place a temporary short circuit at points A & B and find current in that shorted path.

KVL on loop 1:-

$$20 - 2I_1 - 4(I_1 - I_2) = 0$$

$$20 - 2I_1 - 4I_1 + 4I_2 = 0$$

$$-6I_1 + 4I_2 = -20 \quad \text{——— (1)}$$

**KVL on loop 2:-**

$$-4I_2-2(I_2-I_3)-8-4(I_2-I_1)=0$$

**KVL on loop 3:-**

$$-4I_3+4-2(I_3-I_2)=0$$

$$-4I_3+4-2I_3+2I_2=0$$

$$2I_2-6I_3=-4 \quad — \quad (3)$$

- Solving by calculator:-

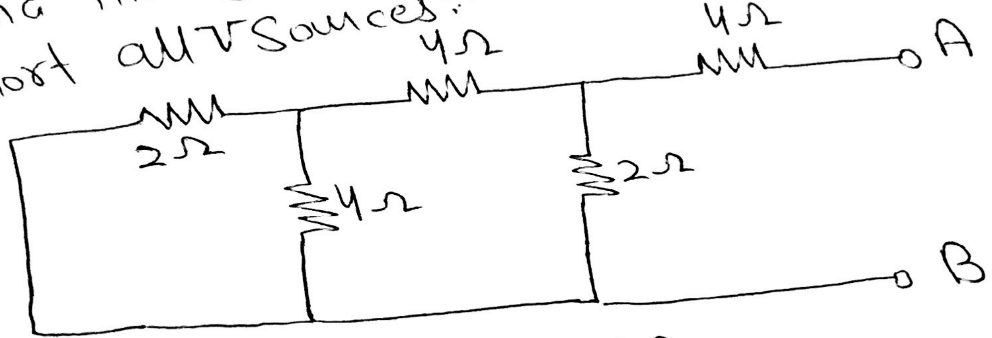
$I_1=$

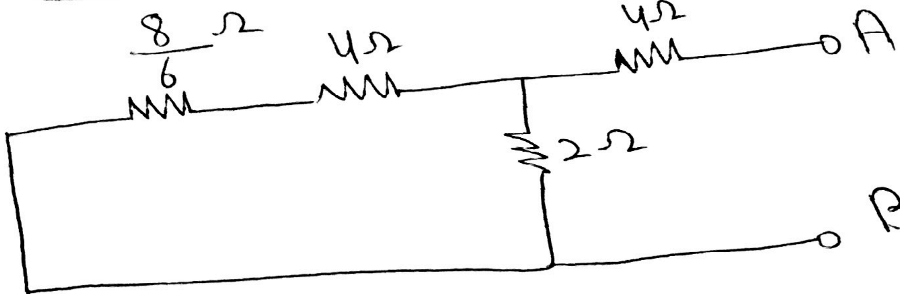
$I_2=$

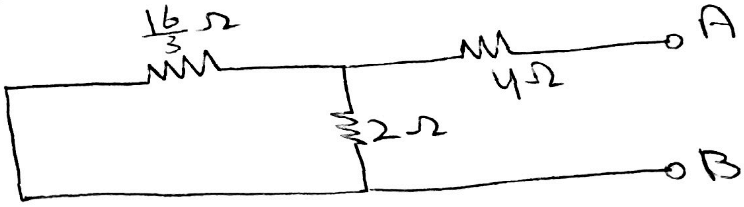
$I_N=I_3=$

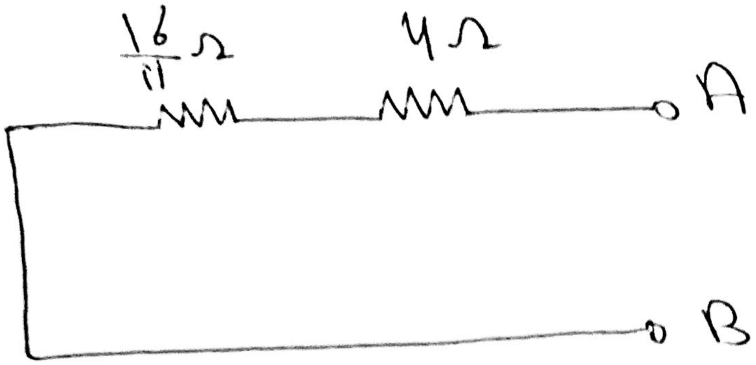
Step 3:-
Find $R_N$ (equivalent resistance)

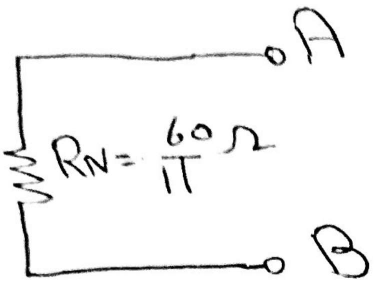
- → Short all V Sources:-



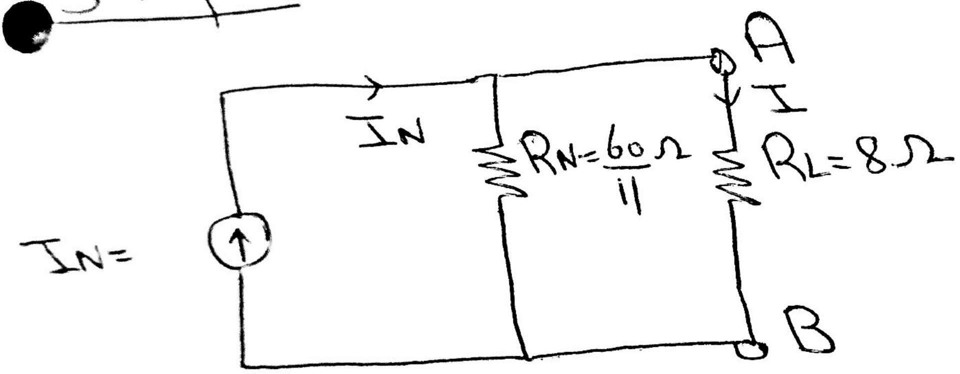






Step 4 :-




$$I = I_N \left( \frac{R_N}{R_N + R_L} \right)$$

# Super Position Theorem:-

## Steps:-

1):- Identify the branch and quantity (V, I, p etc) calculated along with the presence of more than 1 active source.

2):- Consider any 1 source and replace the remaining by their internal resistances.

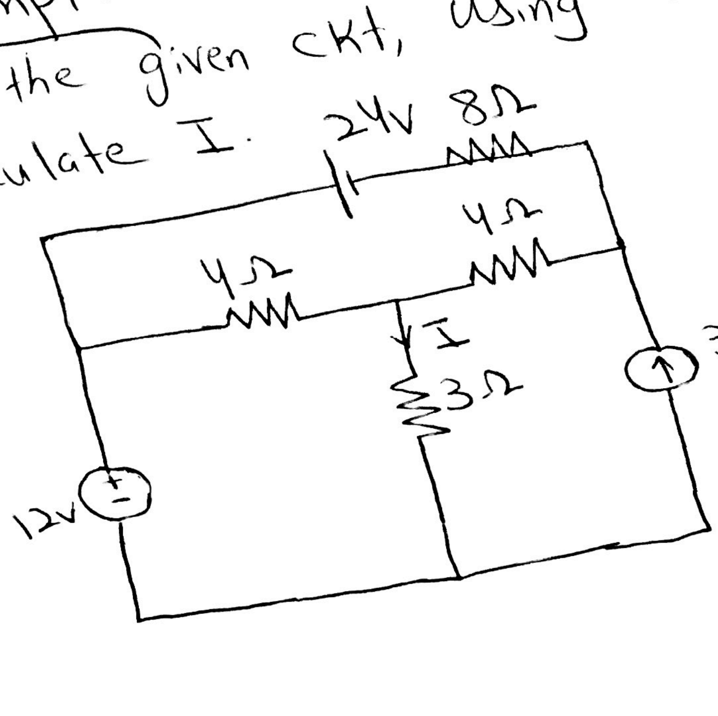
3):- Calculate the required electrical quantity for that particular source.

4):- Repeat the last 2 steps for all the active sources.

5):- Algebraic sum of all these individual source will be the final value of required electrical quantity for all the sources working together.

## Example 1:-

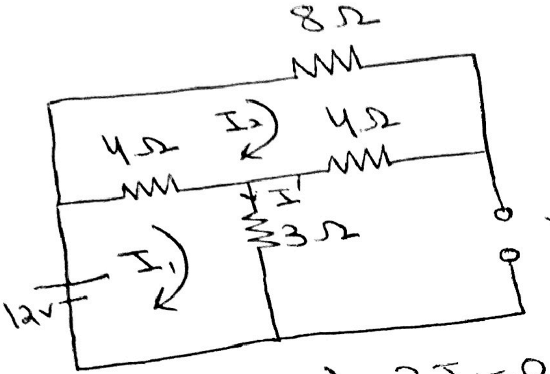
For the given ckt, using the superposition theorem, calculate I.



**Solution:-**

There are 3 active sources in the given network.

Taking 12v source and replacing all the other active sources by their internal resistances:-




{The current source is replaced by an open ckt b/c its internal R is infinite}.

**1st mesh:-** $12 - 4(I_1 - I_2) - 3I_1 = 0$

$-4I_1 + 4I_2 - 3I_1 = -12$

$-7I_1 + 4I_2 = -12$ —— ①

**2nd mesh:-** $-8I_2 - 4I_2 - 4(I_2 - I_1) = 0$

$-8I_2 - 4I_2 - 4I_2 + 4I_1 = 0$

$-8I_2 - 4I_2$ —— ②

$4I_1 - 16I_2 = 0$

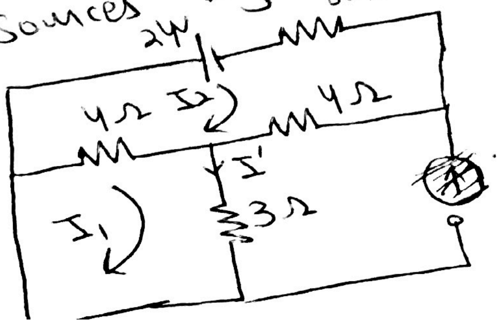
By solving the above 2 eqs:-

$I_1 = 2A$ & $I_2 = 0.5A$

As $I' = I_1$

So $\boxed{I'_{(12v)} = 2A}$

Now taking 24v source and replacing all the other active sources by their internal resistances:-



For mesh ①:-

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

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

$$-7I_1 + 4I_2 = 0 \quad \text{—} ①$$

For mesh ②:-

$$-24 - 8I_2 - 4I_2 - 4(I_2 - I_1) = 0$$

$$-24 - 8I_2 - 4I_2 - 4I_2 + 4I_1 = 0$$

$$4I_1 - 16I_2 = 24 \quad \text{—} ②$$

- By solving eq ① & ②

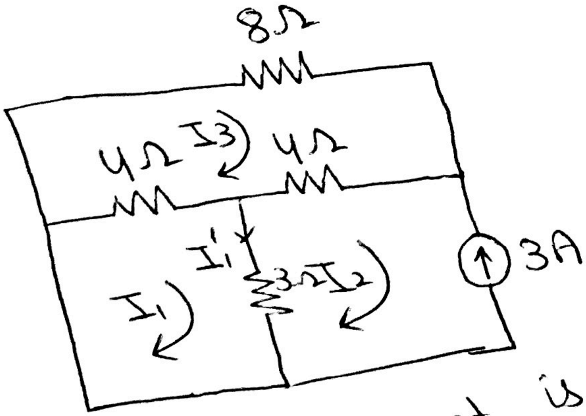
$$I_1 = -1A$$

$$\& \; I_2 = -1.75A$$

As $I'_{(24V)} = I_1$

Hence $\boxed{I'_{1(24V)} = -1A}$

- Now 3A Source & replacing all the other active Sources by their internal resistances:-




In mesh ②, current is given i.e $\boxed{I_2 = -3A}$

now Applying KVL in mesh ①:-

$$-4(I_1 - I_3) - 3(I_1 - I_2) = 0$$

$$-4(I_1 - I_3) - 3I_1 - 9 = 0$$

$$-4I_1 + 4I_3 - 3I_1 = 9$$

$$-7I_1 + 4I_3 = 9 \quad \text{—} ①$$

Now Applying in mesh (3)

$-8I_3 - 4(I_3 - I_2) - 4(I_3 - I_1) = 0$

$-8I_3 - 4I_3 + 4I_2 - 4I_3 + 4I_1 = 0$

$4I_1 + 4I_2 - 16I_3 = 0$

$4I_1 + 4(-3) - 16I_3 = 0$

$4I_1 - 16I_3 = 12$ —— (2)

By solving eq (1) & (2)

$\Rightarrow I_1 = -2A$ & $I_3 = -1.25A$

As $I'_{(3A)}$ $I_1 - I_2$ ( $I_1$ is written first b/c $I'$ is in direction of $I_1$)

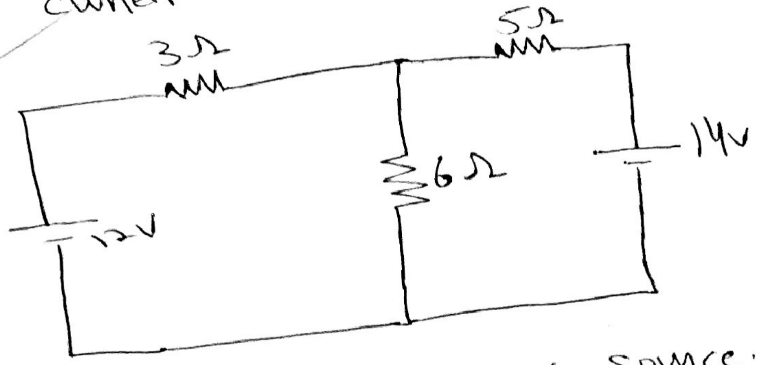
$I'_{(3A)} = (-2+3) = \boxed{1A}$

$I_{total} = I'_1 + I'_2 + I'_3$

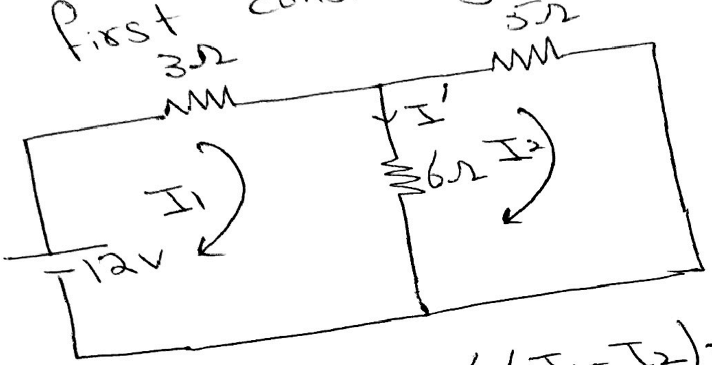
$= 2 - 1 + 1$

$\boxed{I_{total} = 2A}$ Ans:-

Q:- Find current in 6Ω resistor using Superposition Theorem;




Soln:- First considering 12V source:-




mesh (i):- $12 - 3I_1 - 6(I_1 - I_2) = 0$

$-3I_1 - 6I_1 + 6I_2 = -12$

$-9I_1 + 6I_2 = -12$ —— (1)

mesh 2:-

$-6(I_2 - I_1) - 5I_2 = 0$

$-6I_2 + 6I_1 - 5I_2 = 0$

$6I_1 - 11I_2 = 0$ —— (2)

$$\begin{bmatrix} -9 & 6 \\ 6 & -11 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} -12 \\ 0 \end{bmatrix}$$

$I_1 = 2.095A$

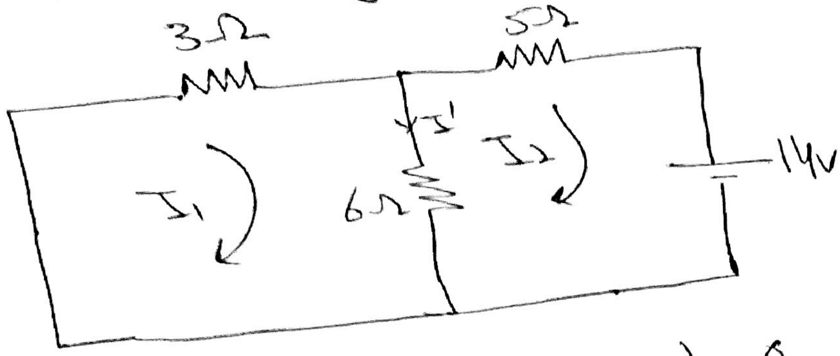
$I_2 = 1.14A$

As $I'_{(12V)} = I_1 - I_2$

$I'_{(12V)} = 2.095 - 1.14$

$$\boxed{I'_{(12V)} = 0.955A}$$

Now taking 14v Source:-




mesh①:- $-3I_1 - 6(I_1 - I_2) = 0$

$-3I_1 - 6I_1 + 6I_2 = 0$

$-9I_1 + 6I_2 = 0$ — ①

mesh②:-

$-5I_2 - 14 - 6(I_2 - I_1) = 0$

$-5I_2 - 6I_2 + 6I_1 = 14$

$6I_1 - 11I_2 = 14$ — ②

$\Rightarrow$ $I_1 = -1.33A$, $I_2 = -2A$

As $I'_{(14v)} = I_1 - I_2$

$= -1.33 + 2$

$\boxed{I'_{(14v)} = 0.67A}$

Now $I = I'_{(12v)} + I'_{(14v)}$

$= 0.955 + 0.67$

$\boxed{I = 1.62A}$