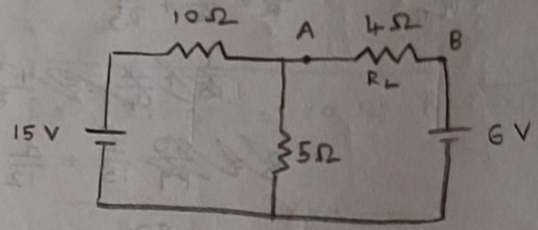
26.9.24

THEVENIN'S THEOREM :

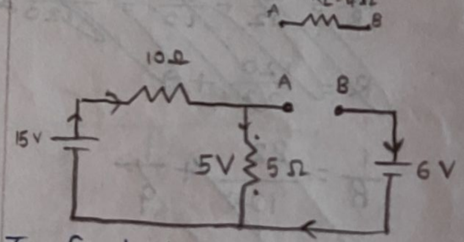
"It provides a mathematical technique for replacing a given network as viewed from two output terminals by a single voltage source with a series resistance."

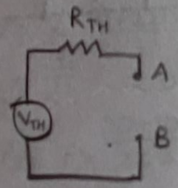
Q)



By Thevenin's Theorem :

1) Remove the load resistance (R_L) from the circuit.
2) Determine V_{TH}.
3) Determine R_{TH} (Equivalent resistance)





To find V_{TH} :

$R = 10 + 5 = 15\,\Omega$

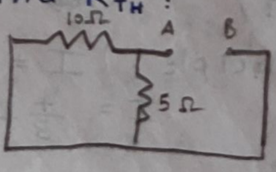
$I = \frac{V}{R} = \frac{\cancel{15}}{\cancel{15}} = 1\,A$

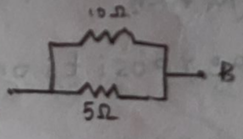
$\therefore$ V through 5Ω = $IR = 1(5) = 5\,V$

V with respect to A B ;

$-6\,V + 5V = -1\,V$

To find R_{TH} :

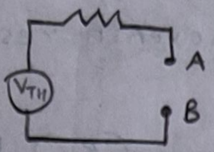




$\frac{1}{R_{TH}} = \frac{1}{10} + \frac{1}{5}$

$= \frac{5+10}{50} = \frac{15}{50}$

$R_{TH} = \frac{10}{3}$



Current :

$$I = \frac{V_{TH}}{R_{TH}+R_L} = \frac{-1}{\frac{10}{3}+4}$$

$$= \frac{-1}{\frac{10+12}{3}} = -\frac{3}{22}$$

$$= -0.136\,A$$

The current flowing through a load resistance (R_L) connected across any two terminals A and B of a linear active bilateral network is given by $V_{TH} / R_{TH} + R_L$, where

$V_{TH} \rightarrow$ Thevenin voltage (open source voltage)

$R_{TH} \rightarrow$ Thevenin resistance (equivalent circuit resistance)

$R_L \rightarrow$ Load resistance.

STEPS TO THEVENISE A GIVEN CIRCUIT :

Step 1) : Temporarily remove the resistance (load resistance) whose current is to be

Step 2) : Find the open circuit voltage (V_{TH}) which appears across the two terminals, from where resistance has been removed. It is also called as Thevenin voltage.

Step 3) : Compute the resistance of the whole network as looked into from these two terminals after all voltage sources are replaced by its internal resistance (if any) or all current sources are replaced by open circuit. It is also called Thevenin resistance (R_{TH})

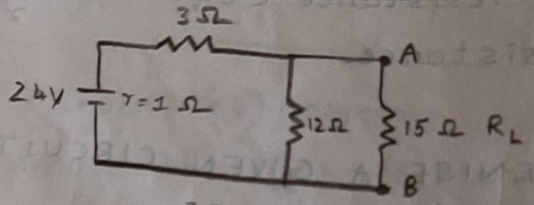
Step 4): Replace the entire network by a single Thevenin source and Thevenin resistance in series.

Step 5): Connect load resistance (R_L) back to its terminals from where it was previously removed.

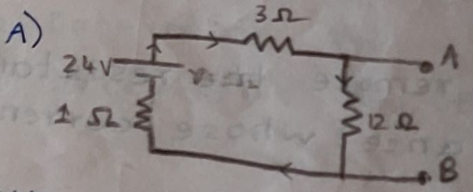
Step 6): Finally calculate the current flowing using the equation.

$$\boxed{I = \frac{V_{TH}}{R_{TH} + R_L}}$$

Q)



A)

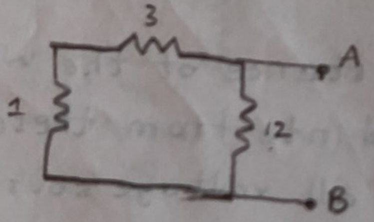


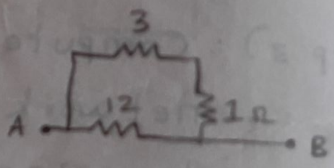
Voltage across A B;

$R = 3 + 12 + 1 = 16\ \Omega$

$I = \frac{V}{R} = \frac{\cancel{24}}{\cancel{16}} = \frac{\cancel{12}}{\cancel{8}} = \frac{\cancel{6}}{\cancel{4}} = \frac{3}{2}$ A

$V_{TH} = \overset{6}{\cancel{12}}\left(\frac{3}{\cancel{2}}\right) = 18$ V





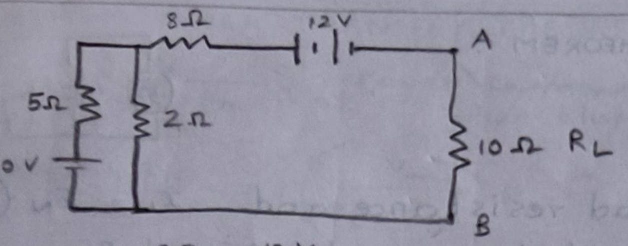
$\frac{1}{R} = \frac{1}{4} + \frac{1}{12}$

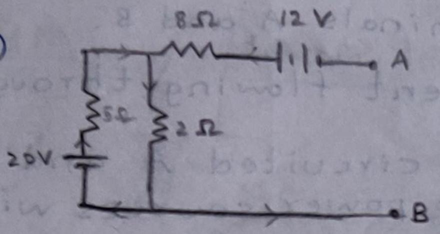
$= \frac{12+4}{48} = \frac{\cancel{16}}{\cancel{48}} \frac{\cancel{4}}{\cancel{12}} = \frac{1}{3}$

$R = 3\ \Omega$

$R_{TH} = 3\ \Omega$

$\therefore I = \frac{V_{TH}}{R_{TH} + R_L} = \frac{18}{3+15} = \frac{\cancel{18}}{\cancel{18}} = 1$ A

Q) 

A) 

$\cancel{\frac{1}{R} = \frac{1}{5} + \frac{1}{2} = \frac{2+5}{10} = \frac{7}{10}}$

$R = \cancel{\frac{10}{7}}\ 7$; $\cancel{I = \frac{V}{R} = \frac{20}{7} = 14\ A}$

$R = 5 + 2 = 7$; $I = \frac{V}{R} = \frac{20}{7}\ A$

V through $2\,\Omega$; $V = IR = \frac{20}{7} \times 2 = \frac{40}{7}\ V$

$V_{TH} = \frac{40}{7} - 12 = \frac{40-84}{7} = -\frac{44}{7}\ V$

∴ Change the terminals; (∵ $A^{\ominus}$, $B^{\oplus}$)

$\frac{1}{R} = \frac{1}{5} + \frac{1}{2} = \frac{2+5}{10} = \frac{7}{10}$

$R = \frac{10}{7}$

∴ $R_{TH} = \frac{10}{7} + 8 = \frac{10+56}{7} = \frac{66}{7}\ \Omega$

Using Thevenin's Theorem;

$$I = \frac{V_{TH}}{R_{TH} + R_L}$$

$$= \frac{\frac{44}{7}}{\frac{66}{7} + 10} = \frac{\frac{44}{\cancel{7}}}{\frac{66+70}{\cancel{7}}} = \frac{44}{136} = 0.323\ A$$