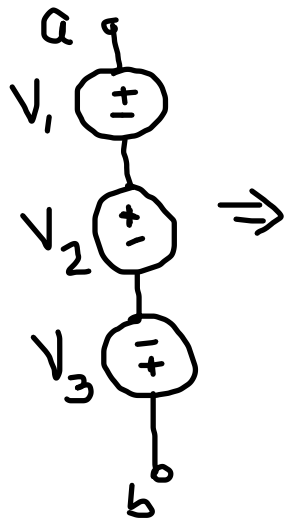
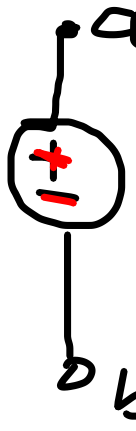
Interconnection of Voltage and Current sources

① Voltage Sources

A

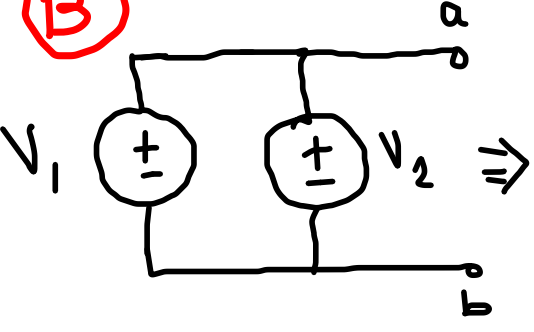


$\Rightarrow$



$V_1+V_2-V_3$

B



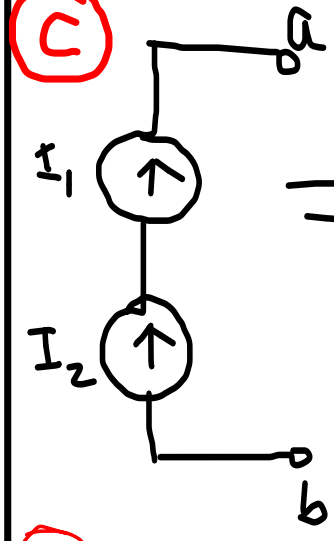
$\Rightarrow$

$V=V_1=V_2$

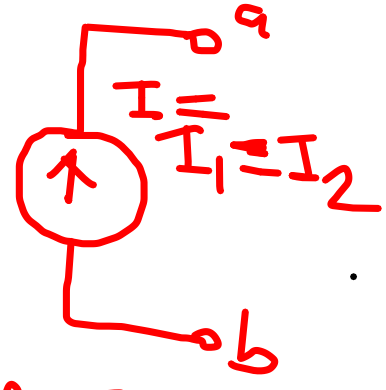
if $V_1 \neq V_2$ paralled connection not allowed

② Current Sources

C

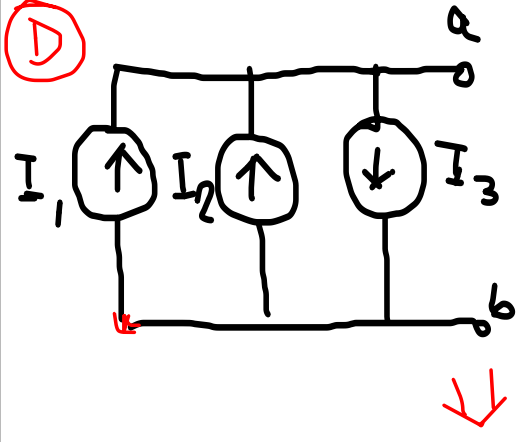


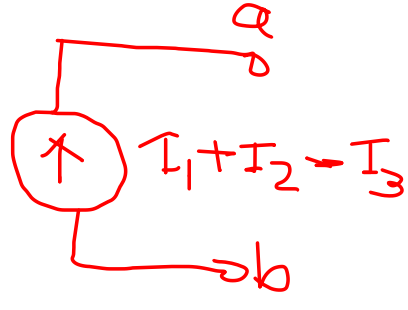
$\Rightarrow$



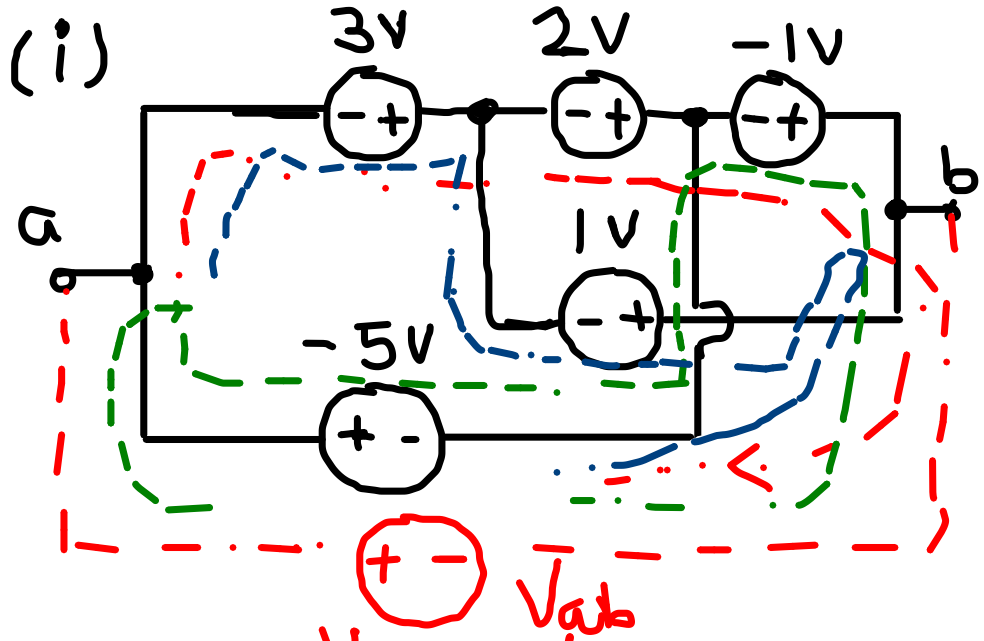
If $I_1 \neq I_2$ Series connection Not allowed

D





Example-1: Replace the following network with (i) Vab (ii) lab



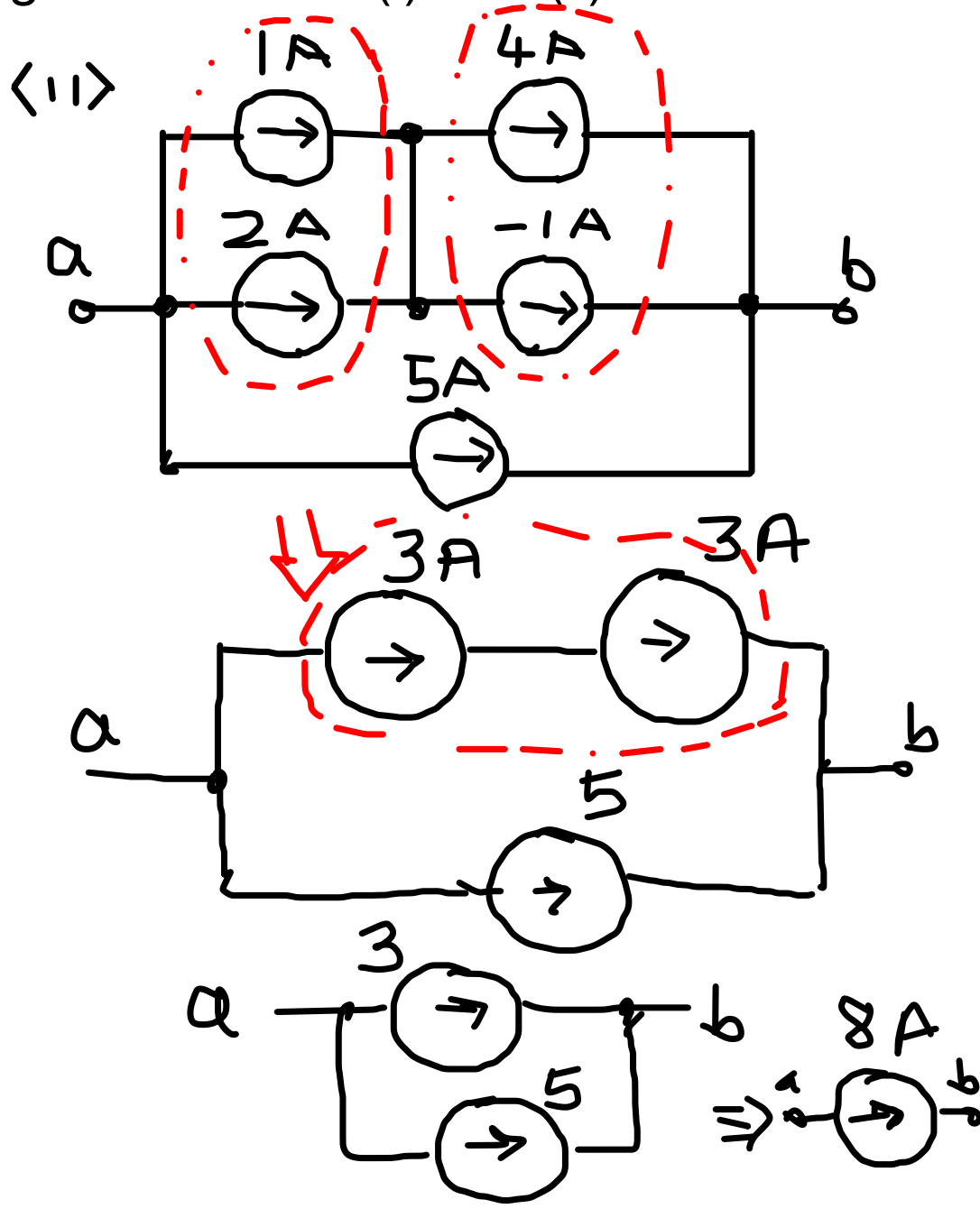
$V_{ab} + 3 + 1 = 0 \quad V_{ab} = -4V$

$V_{ab} + 3 + 2 + (-1) = 0$

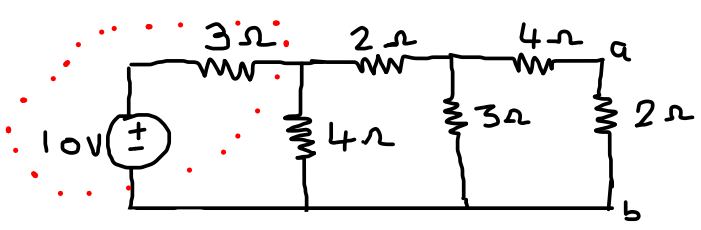
$V_{ab} = -4V$

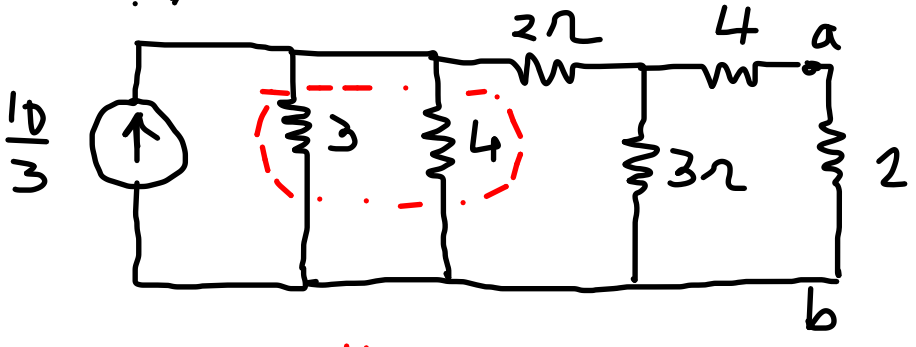
$V_{ab} - (-5) + (-1) = 0$

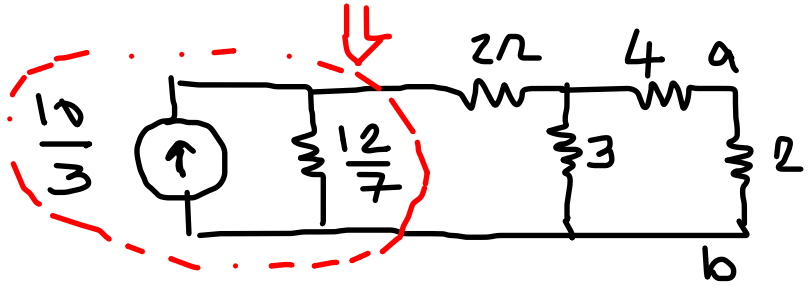
$V_{ab} = -4V$

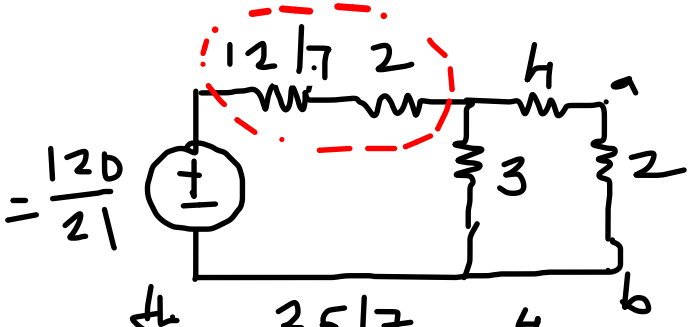


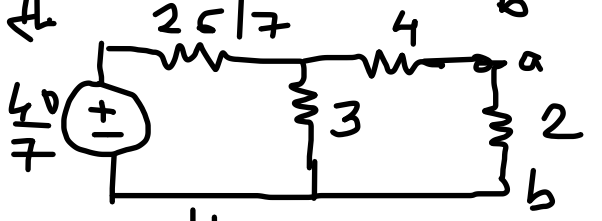
Example-2: Find Voltage Vab using Source Transformation

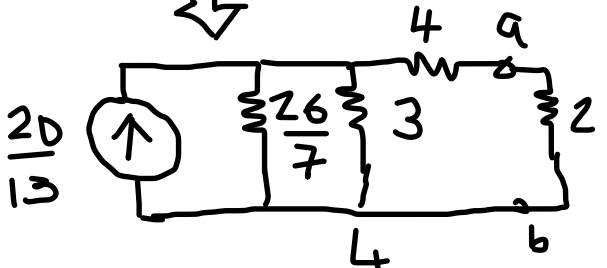


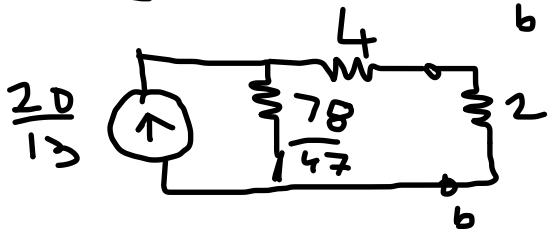


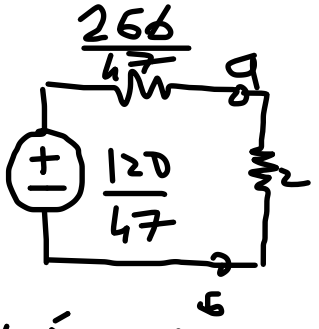










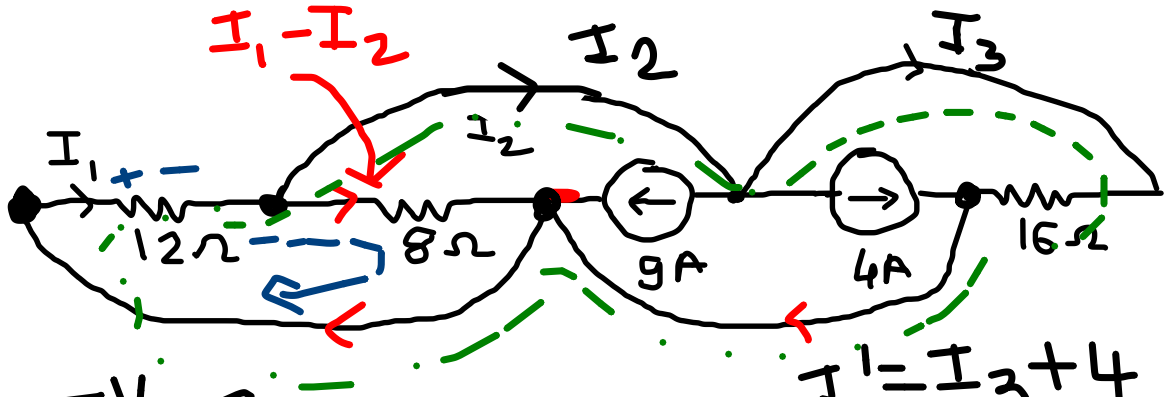


Using Voltage division

$$V_{ab} = \frac{2 \times \frac{120}{47}}{2 + \frac{266}{47}}$$

$$V_{ab} = \frac{2}{3} V$$

Example-3: Determine currents I1, I2 and I3



$I' = I_1 - I_2 + 9 + I_3 + 4$

$I' = I_3 + 4$

$I'' = I_1$

$I_1 - I_2 + 9 + I_3 + 4 = I_1$

$I_2 - I_3 = 13$ ---(1)

Solving eqn (1) (2) (3)

$$\begin{cases} I_1 = 4A \\ I_2 = 10A \\ I_3 = -3A \end{cases}$$

$\Delta =$ $\Delta_2 =$

$\Delta_1 =$ $\Delta_3 =$

$I_1 = \frac{\Delta_1}{\Delta}$

using KVL

$-12I_1 - 8(I_1 - I_2) = 0$

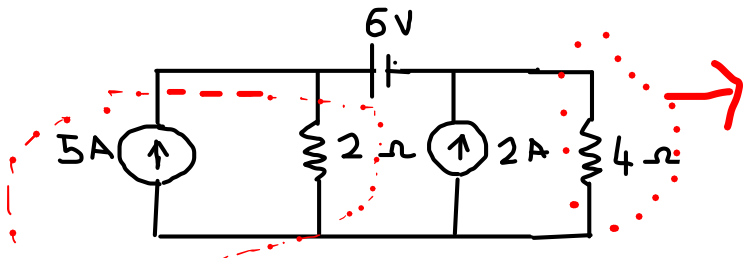
$-20I_1 + 8I_2 = 0$ ---(II)

using KVL

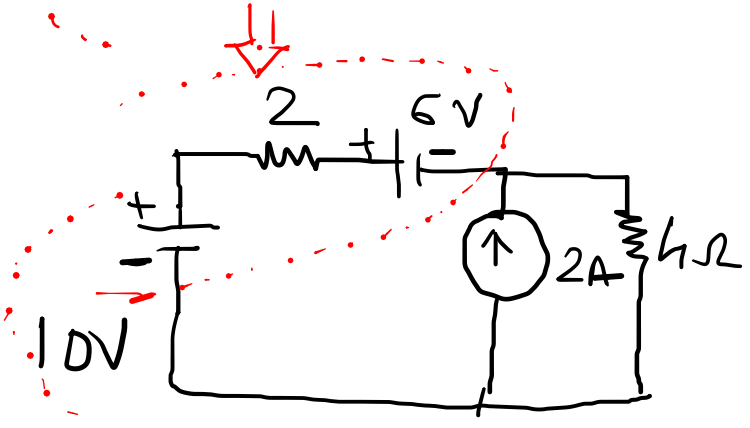
$-12I_1 - 16I_3 = 0$ ---(III)

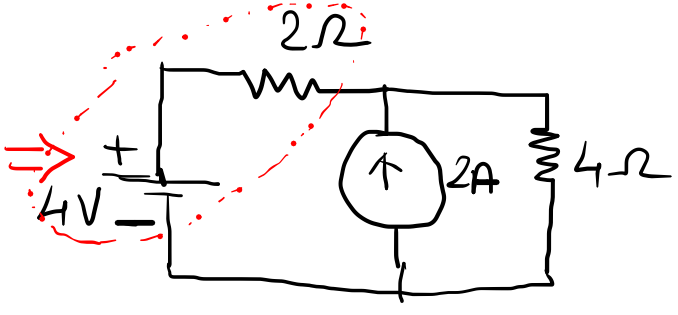
$$\begin{bmatrix} 0 & 1 & -1 \\ -20 & 8 & 0 \\ -12 & 0 & -16 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 13 \\ 0 \\ 0 \end{bmatrix}$$

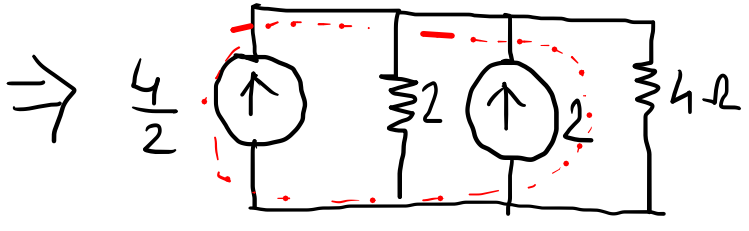
Example-4: Find voltage across 4ohm resistor using Source Transformation.

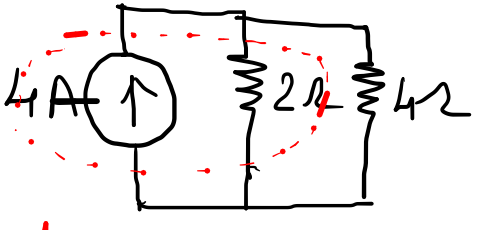


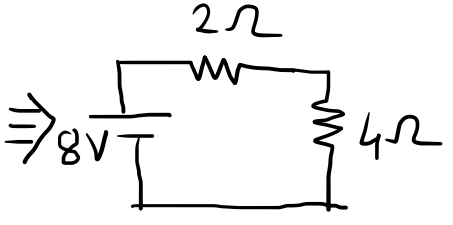
Do not take the resistor into source transformation across which Voltage/current is to be found.







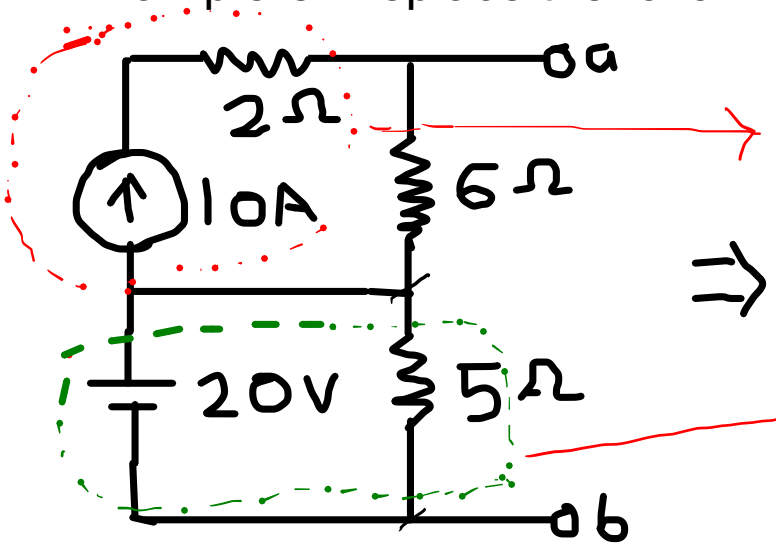




Using Voltage division Rule

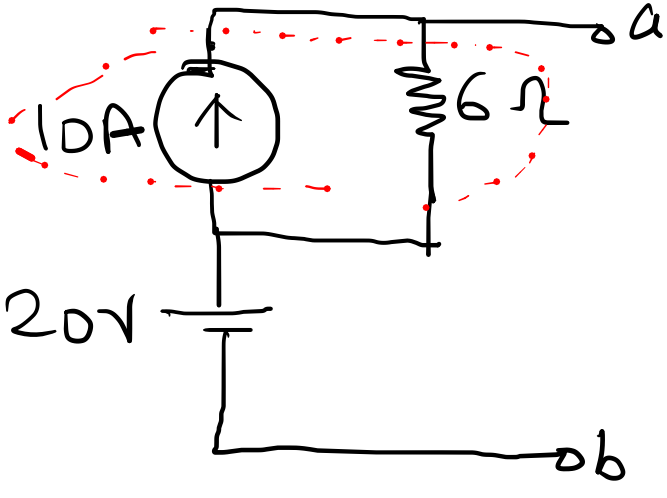
$$V_{4\Omega} = \frac{4 \times 8}{4+2} = \frac{32}{6} = 5.33\,V$$

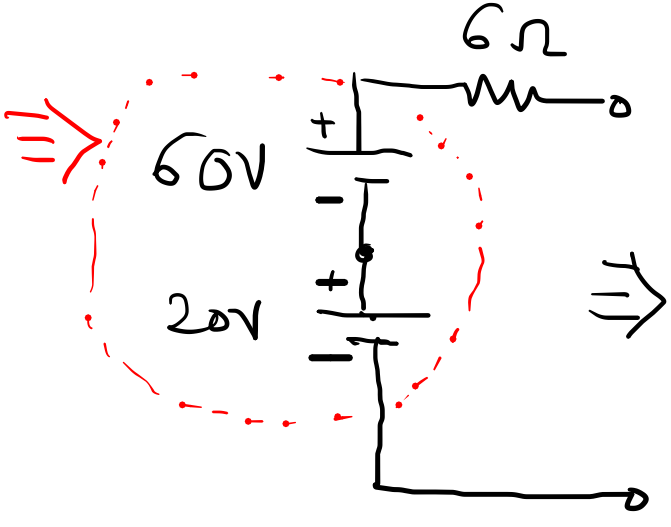
Example-5: Replace the following network with single current source and a resistor

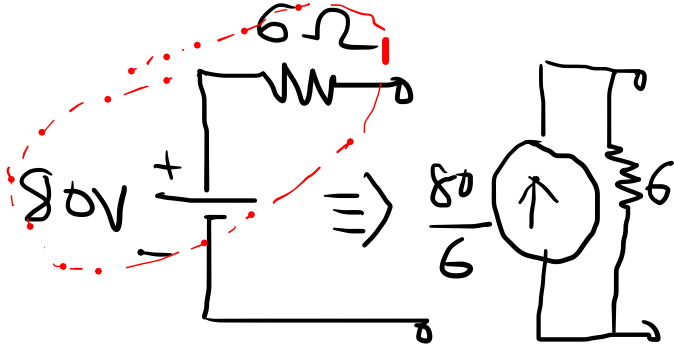


A resistor in series with current source is redundant

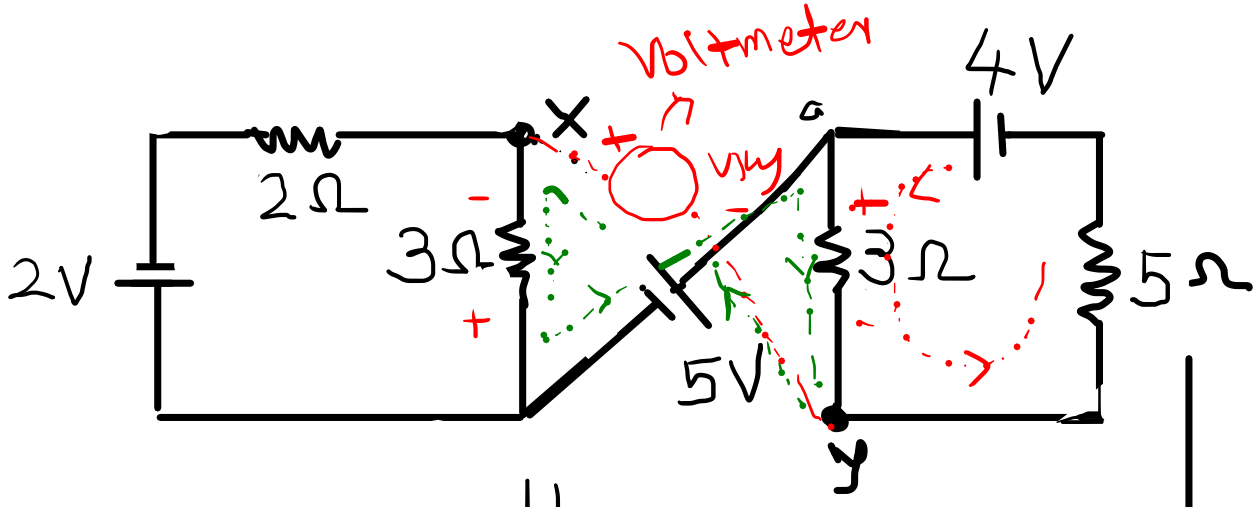
A resistor in parallel with voltage source is redundant

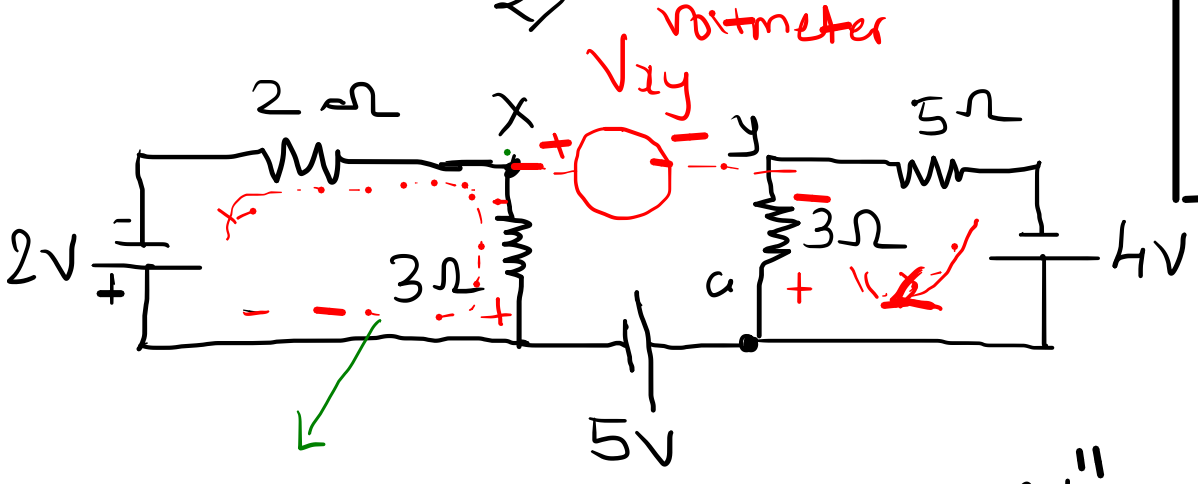






Example-6: Find potential difference Vxy .





KVL to closed loop.

$V_{xy} + (V'_{3\Omega}) + (5) + V''_{3\Omega} = 0$

$=$

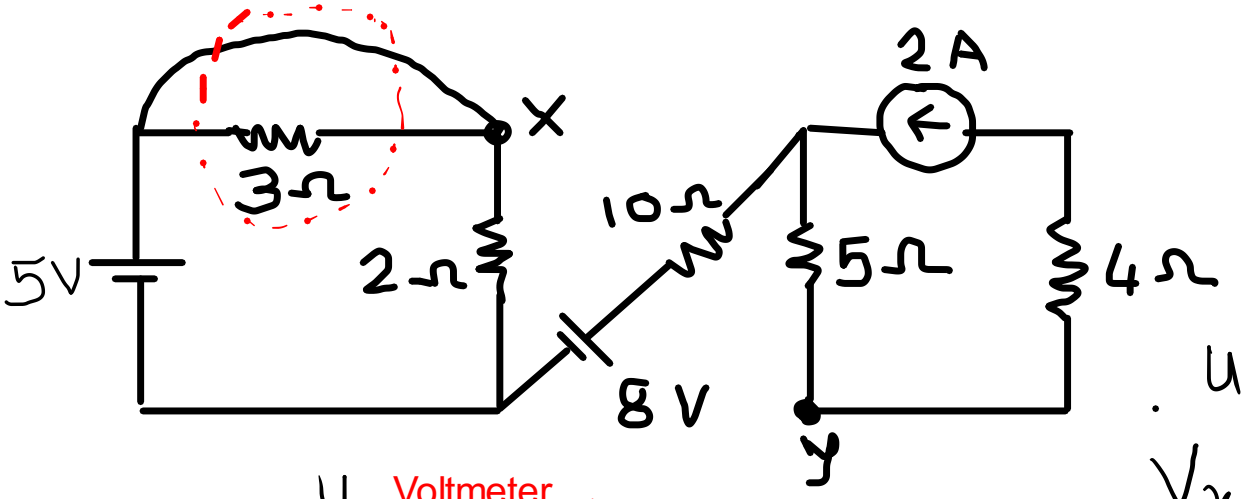
$V_{xy} + \frac{6}{5} + 5 - \frac{12}{8} = 0.$

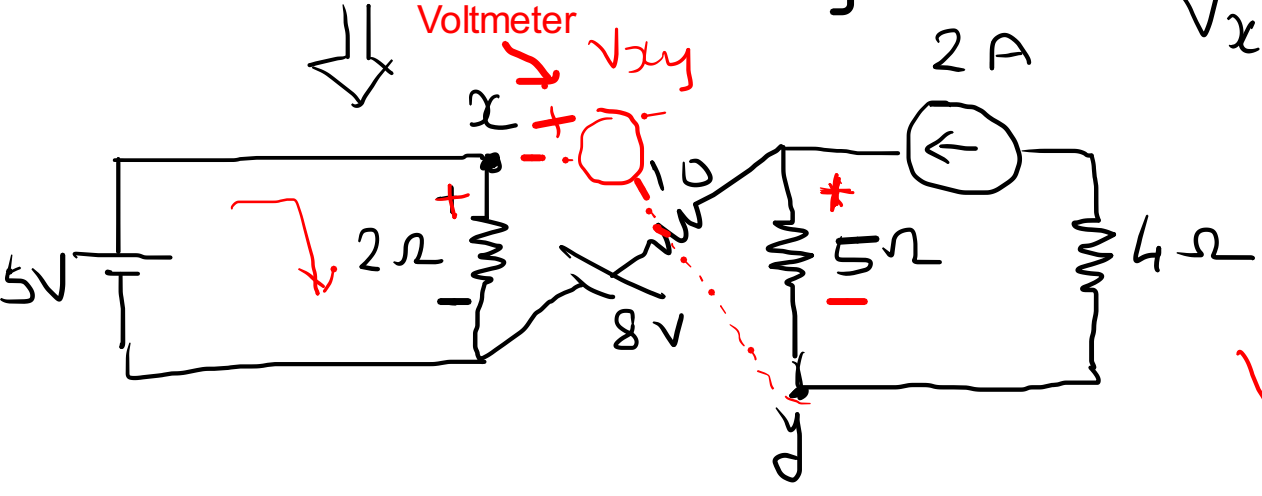
$V_{xy} = -4.7V$

$V'_{3\Omega} = \frac{3 \times 2}{2+3} = \frac{6}{5} V$

$V''_{3\Omega} = \frac{3 \times 4}{3+5} = \frac{12}{8} V$

Example-6: Find potential difference Vxy .





Potential drop across 10 ohm resistor is zero becuase no current flows through it. No close path for current through 10ohm

. Using KVL from Vxy

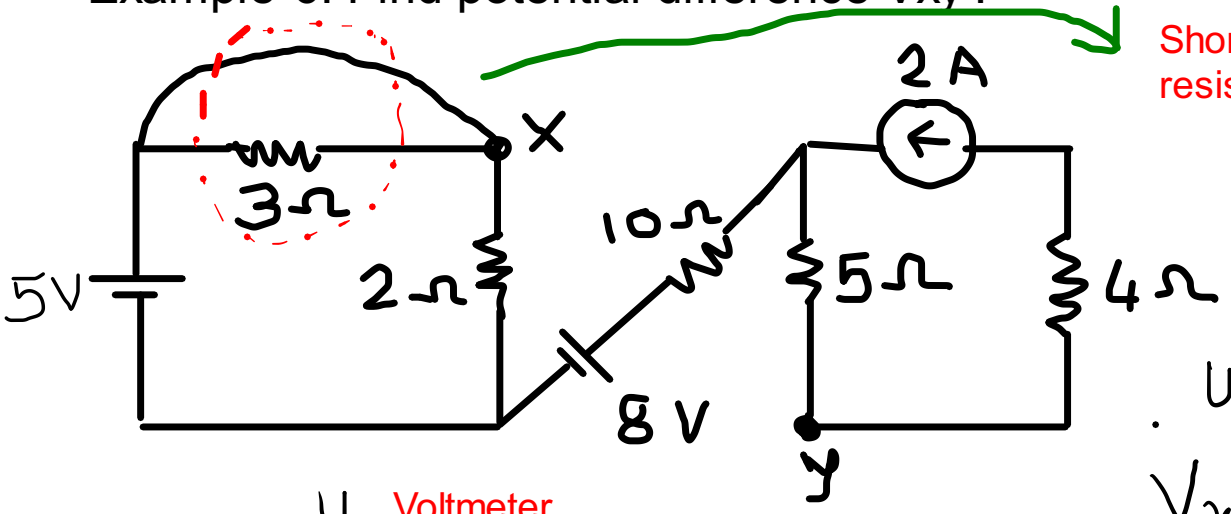
$V_{xy} + (V_{2\Omega}) + 8 + (V_{10\Omega}) + V_{5\Omega} = 0$

$V_{xy} - 5 + 8 + 0 - (5 \times 2) = 0$

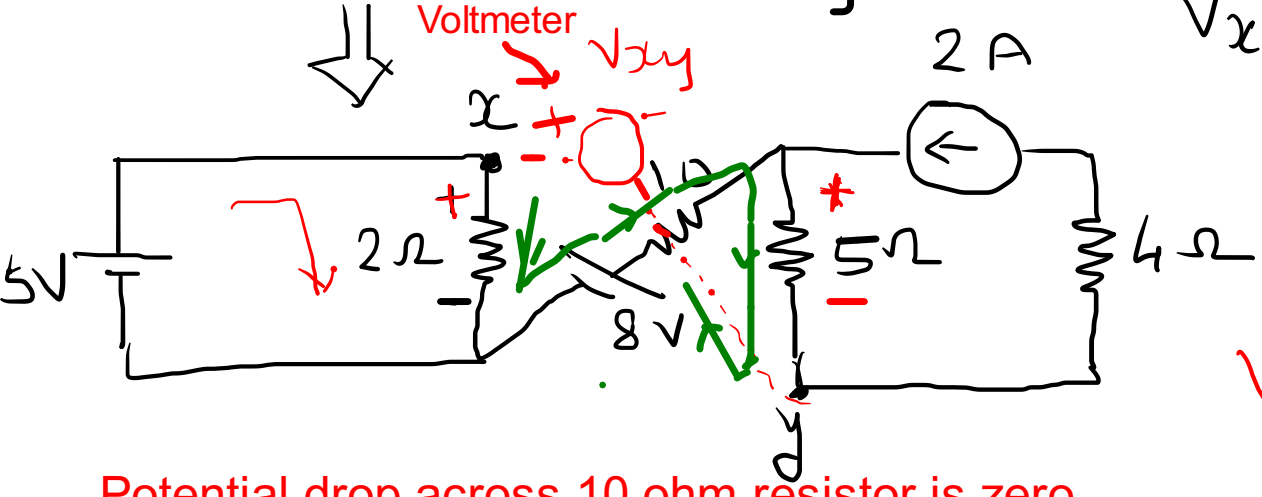
$V_{xy} - 5 + 8 - 10 = 0$

$V_{xy} = 7V$

Example-6: Find potential difference Vxy .



Short circuit across 3 ohm resistor. so equivalent resistance is zero. Req =(3X0)/(3+0).



Potential drop across 10 ohm resistor is zero becuase no current flows through it. No close path for current to flow through 10 ohm.

. Using KVL from Vxy

$V_{xy} + (V_{2\Omega}) + 8 + (V_{10\Omega}) + V_{5\Omega} = 0$

$V_{xy} - 5 + 8 + 0 - (5 \times 2) = 0$

$V_{xy} - 5 + 8 - 10 = 0$

$V_{xy} = 7V$