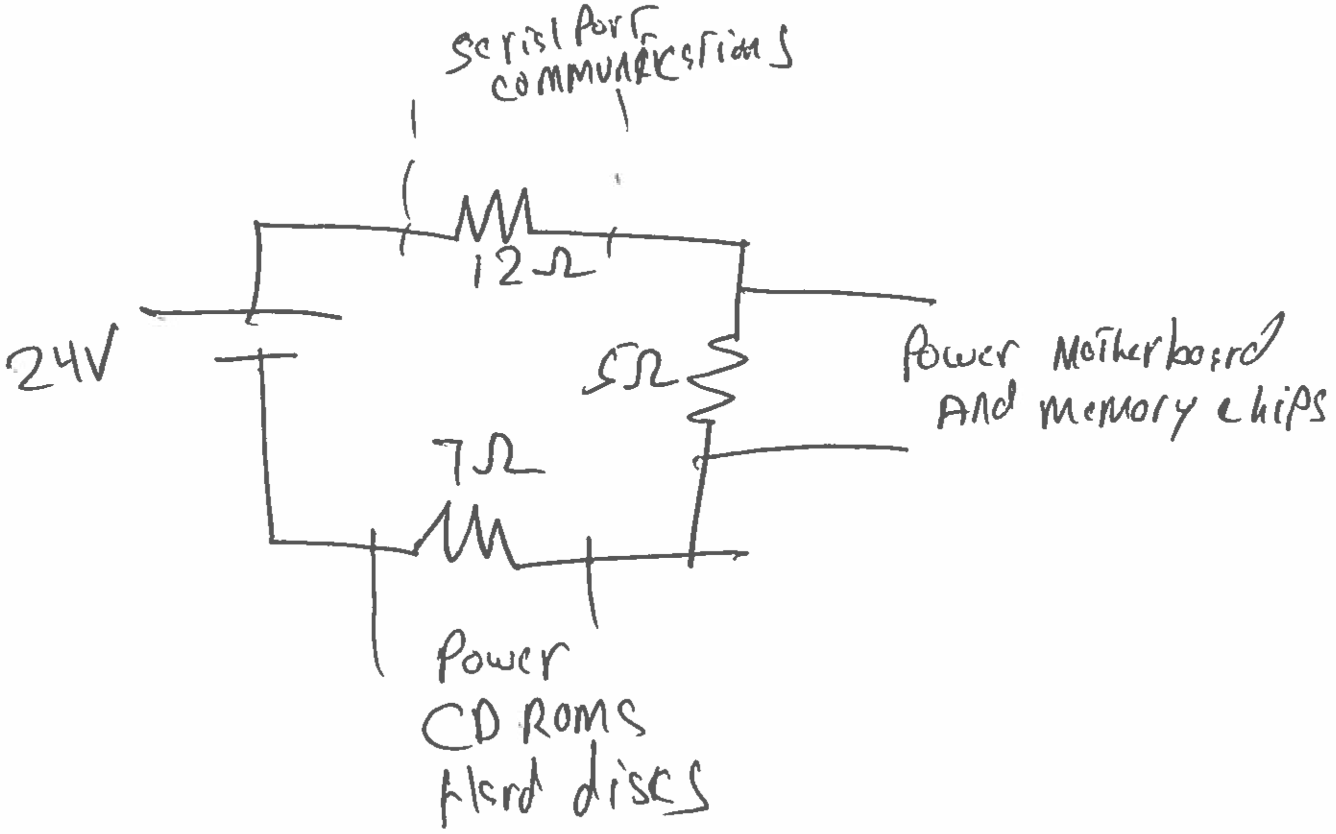
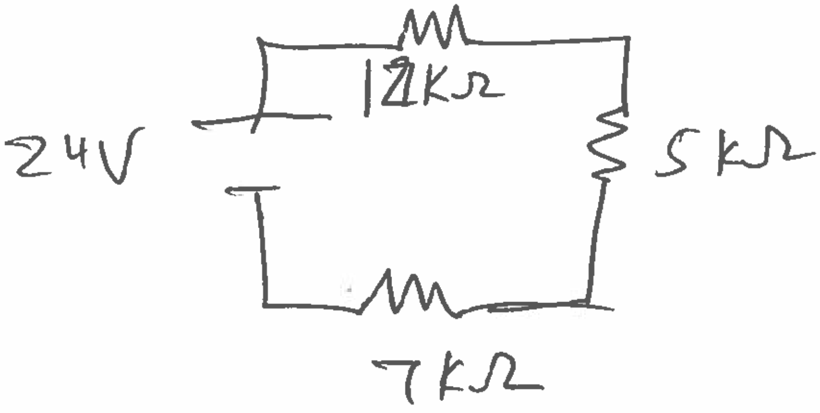
Series circuits are voltage dividers





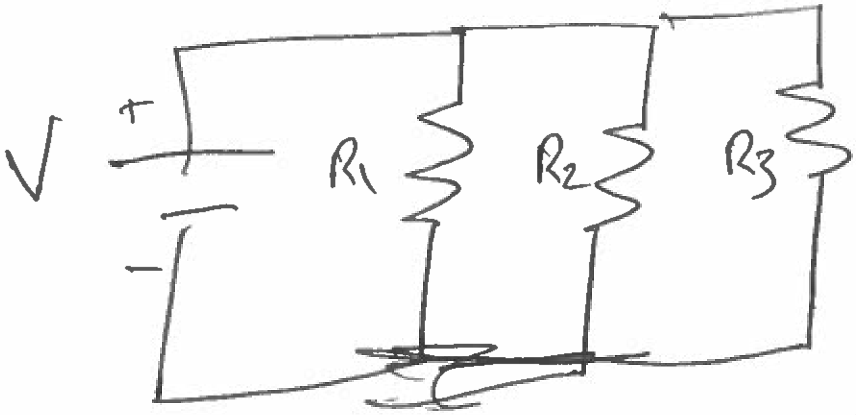
$$R_{TOT} = 12k\Omega + 5k\Omega + 7k\Omega = 24k\Omega$$

$$i = \frac{V_{TOT}}{R_{TOT}} = \frac{24V}{24k\Omega} = 1\,mA$$

$$V_{12k\Omega} = iR = (1mA)(12k\Omega) = 12V$$

Parallel circuits

Two electrical elements are in parallel when both ends are connected together and therefore both parts have the same voltage across them.



These are wired in parallel.

Not Parallel

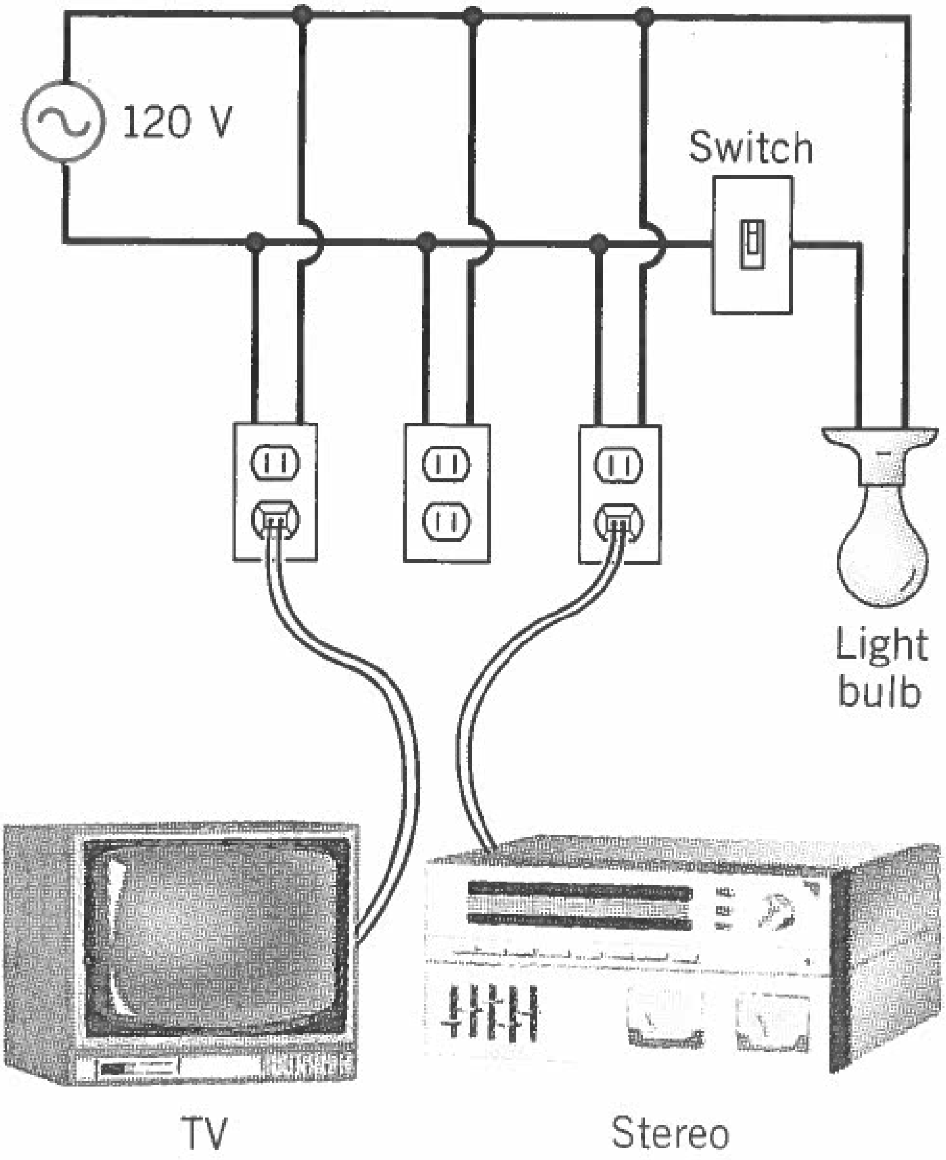
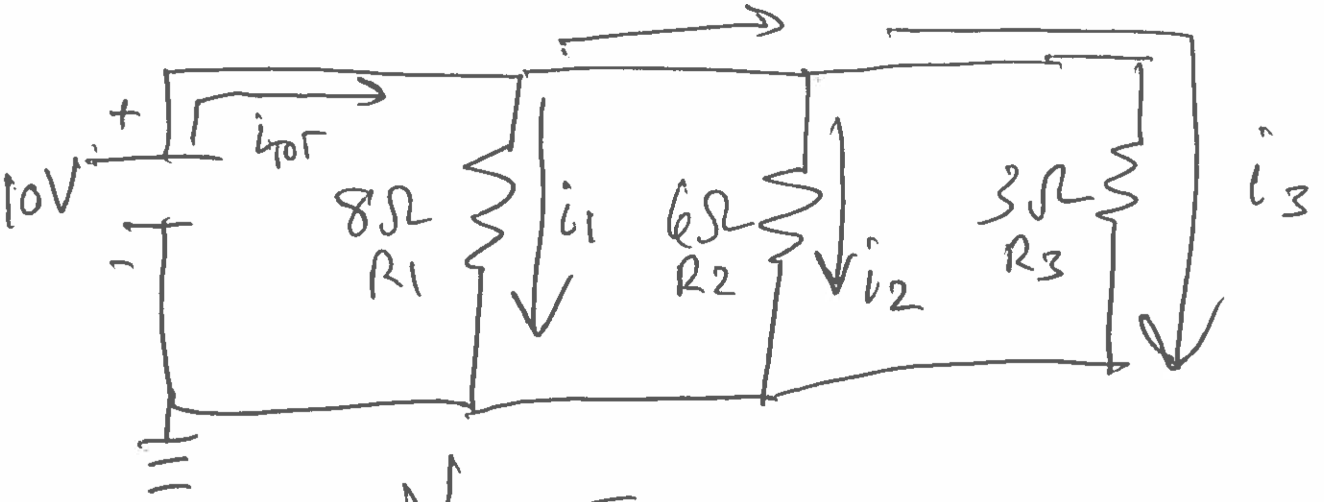


FIGURE 20.16



$$V_{8\Omega} =$$

ohms Law

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

$$i_{TOT} = i_1 + i_2 + i_3$$

$$\frac{V_{TOT}}{R_{TOT}} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}$$

$$V_1 = V_2 = V_3 = V_{TOT}$$

$$\boxed{\begin{aligned} \frac{1}{R_{TOT\,\text{Parallel}}} &= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \\ R_{TOT\,\text{series}} &= R_1 + R_2 + R_3 \end{aligned}}$$

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

$$= \frac{1}{8\Omega} + \frac{1}{6\Omega} + \frac{1}{3\Omega}$$

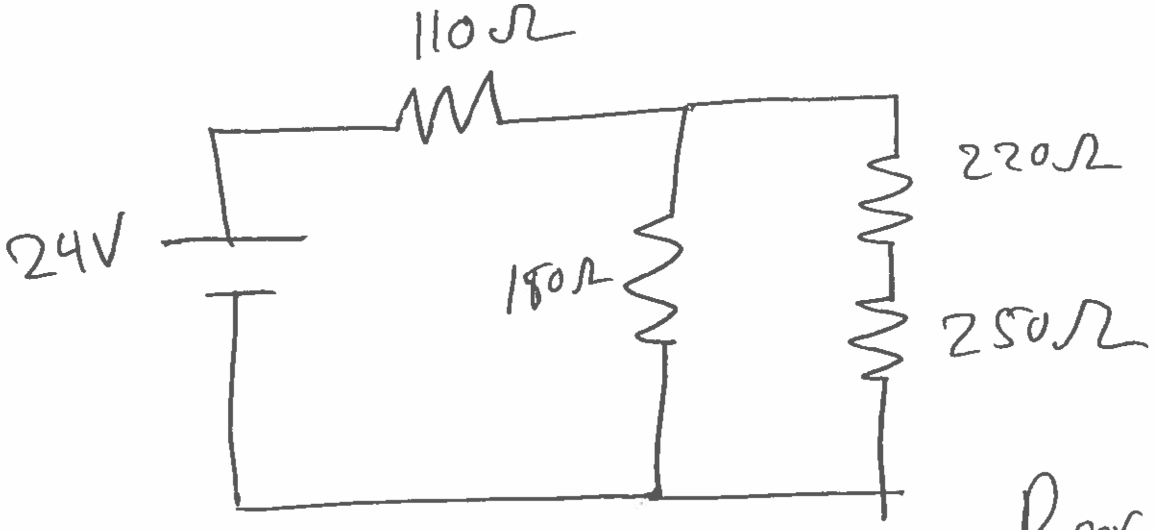
$$\frac{1}{R_{TOT}} = \frac{3}{24\Omega} + \frac{4}{24\Omega} + \frac{8}{24\Omega} = \frac{15}{24\Omega}$$

$$\frac{1}{R_{TOT}} = 0.625\,\frac{1}{\Omega}$$

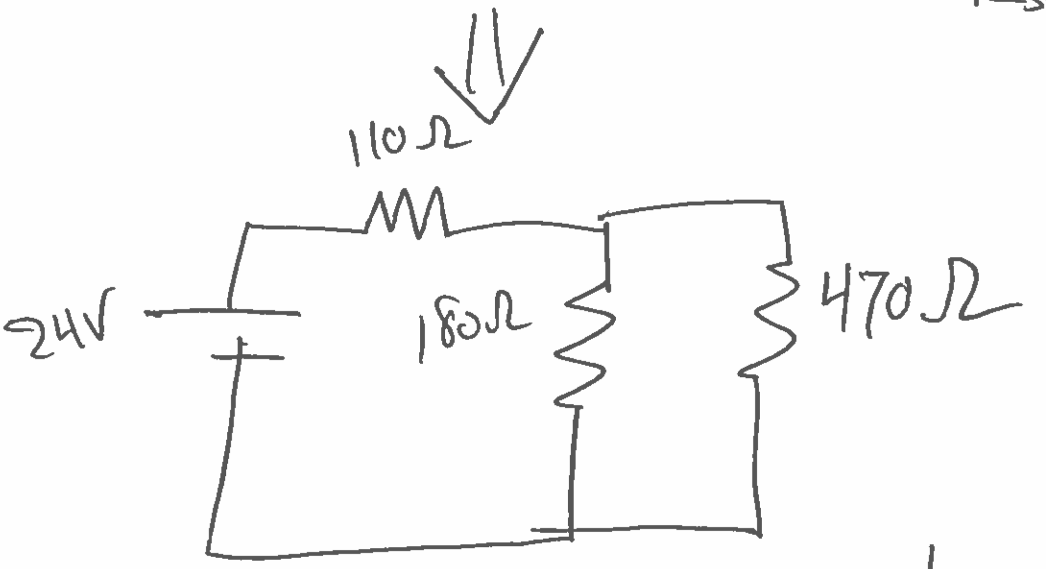
$$R_{TOT} = \frac{1}{0.625\frac{1}{\Omega}} = \boxed{1.6\Omega = R_{TOT}}$$

$$i_{TOT} = \frac{V_{TOT}}{R_{TOT}} = \frac{10V}{1.6\Omega} = 6.25\text{ A}$$

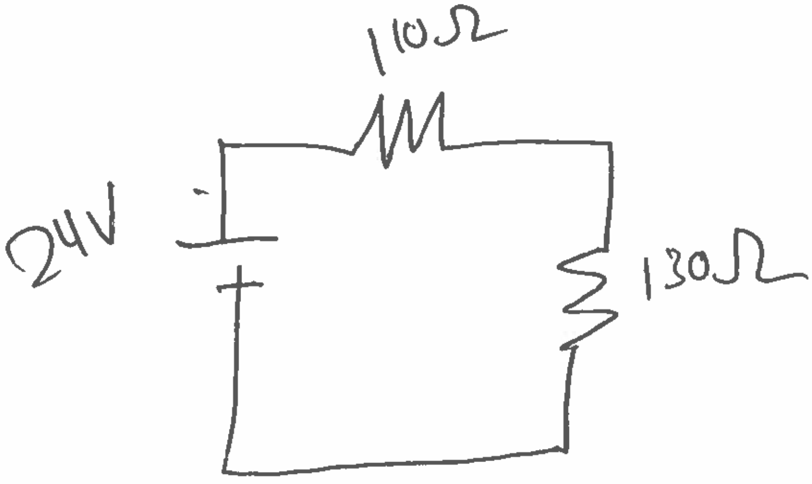
$$\left.\begin{array}{l} i_1 = \frac{V_1}{R_1} = \frac{10V}{8\Omega} = 1.25\text{A} \\ i_2 = \frac{V_2}{R_2} = \frac{10V}{6\Omega} = 1.67\text{A} \\ i_3 = \frac{V_3}{R_3} = \frac{10V}{3\Omega} = 3.33\text{A} \end{array}\right\} \underline{6.25\text{A}}$$



$$R_{ser} = 220\Omega + 250\Omega = 470\Omega$$



$$\frac{1}{R_{par}} = \overset{0.0056\,\Omega^{-1}}{\frac{1}{180\Omega}} + \overset{0.00213\,\Omega^{-1}}{\frac{1}{470\Omega}}$$

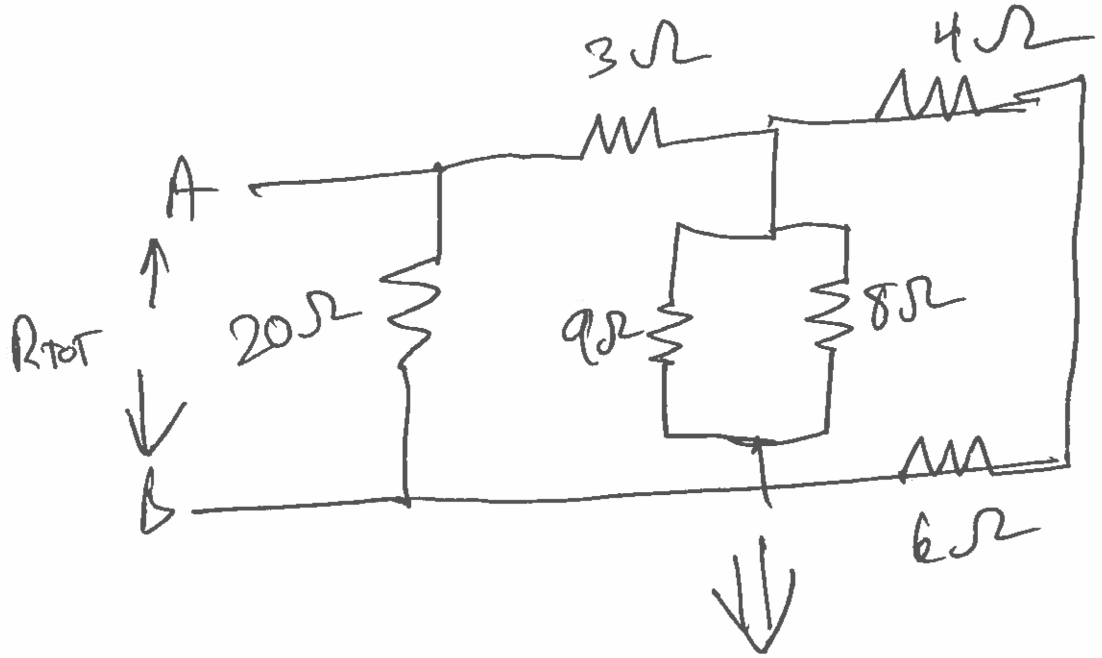


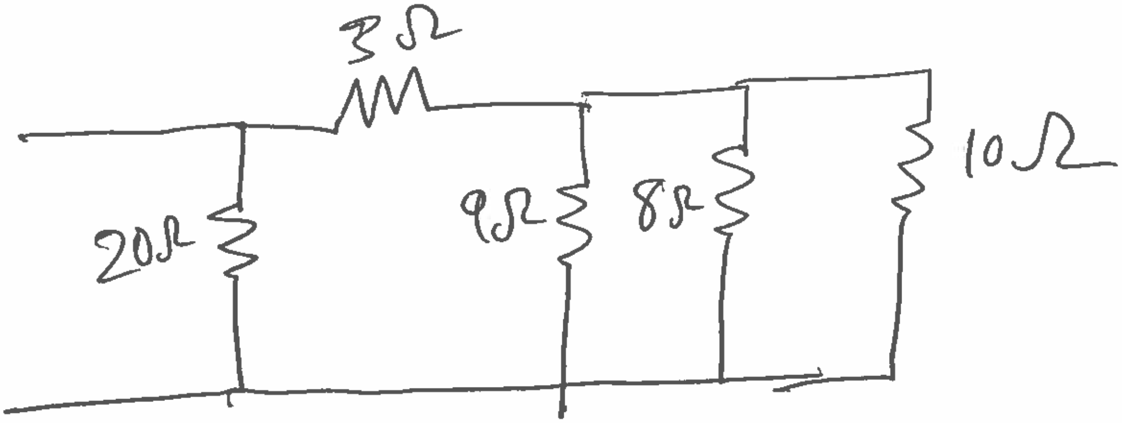
$$\frac{1}{R_{par.}} = \overset{0.00768\,\Omega^{-1}}{\frac{1}{130\Omega}}$$

$$R_{par} = 130\Omega$$

$$R_{final} = 110\Omega + 130\Omega$$
$$= 240\Omega$$

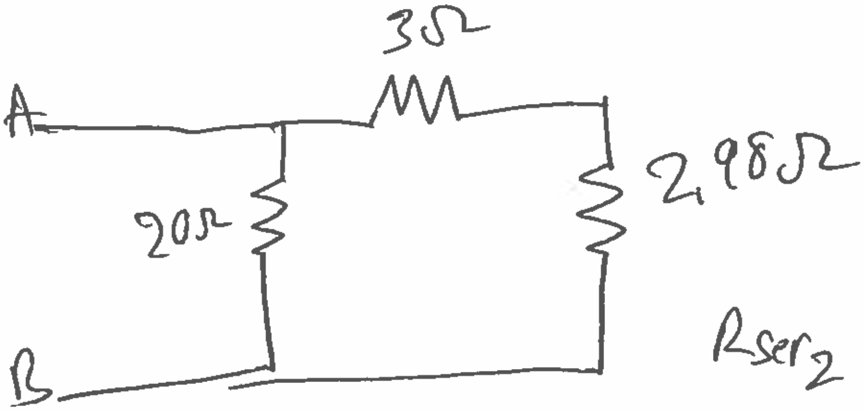
$$i_{tot} = \frac{24V}{240\Omega}$$
$$= 0.10A = 100mA$$



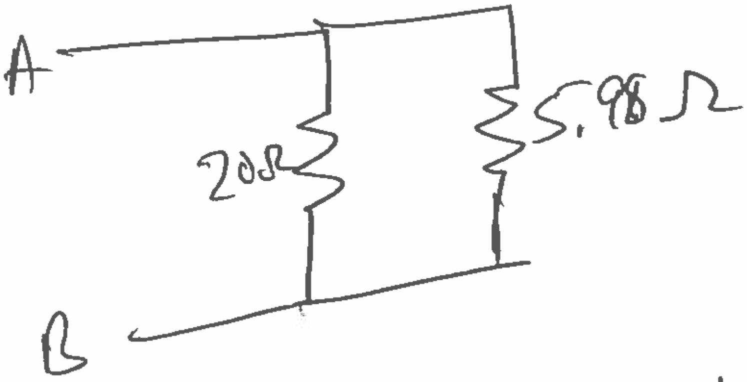


$$\frac{1}{R_{Par_1}} = \frac{1}{9\Omega} + \frac{1}{8\Omega} + \frac{1}{10\Omega}$$

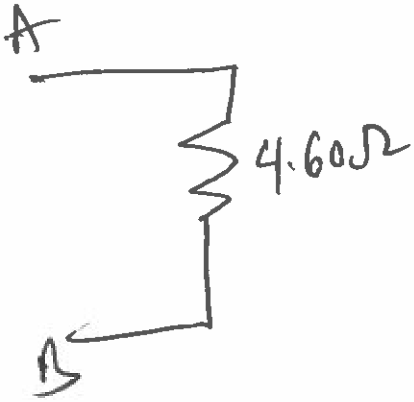
$$R_{Par1} = 2{,}98\Omega$$



$$R_{ser_2} = 3\Omega + 2{,}98\Omega = 5{,}98\Omega$$



$$\frac{1}{R_{TOT}} = \frac{1}{20\Omega} + \frac{1}{5.98\Omega}$$

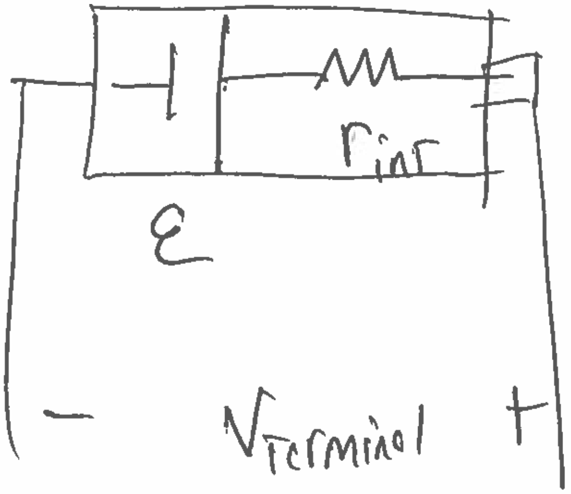


$$\boxed{R_{TOT} = 4.60\ \Omega}$$

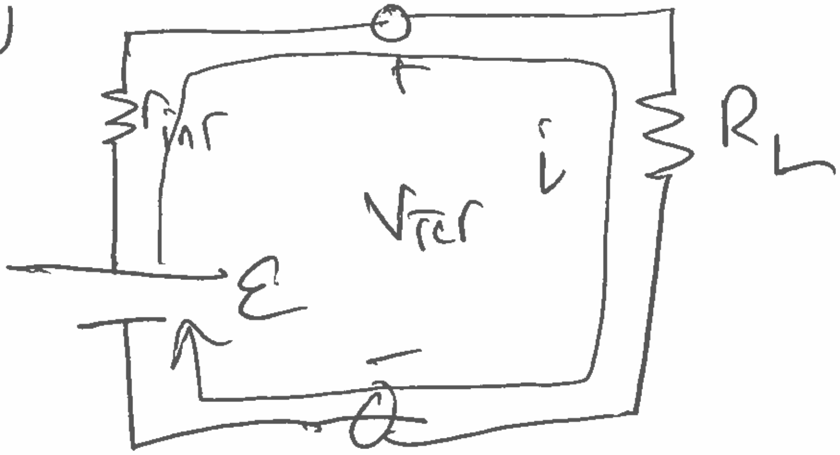
Batteries

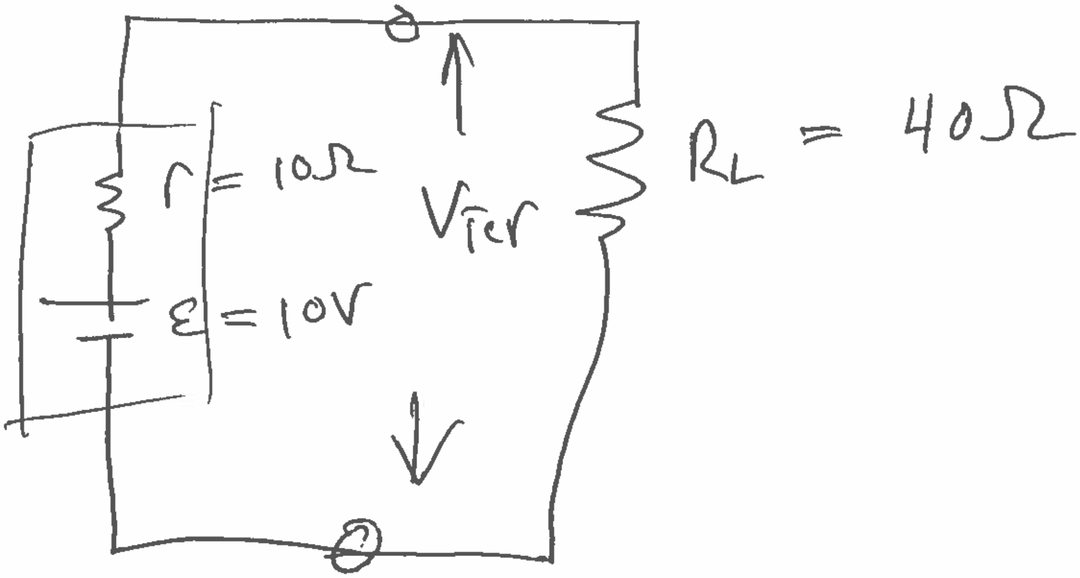
We think as absolute potential differences.

But their potential difference decreases over use.



Putting a load on terminals causes current flow





$$V_{RL} = ? = V_{ter}$$

$$i = \frac{V_{TOT}}{R_{TOT}} = \frac{10V}{10\Omega + 40\Omega} = \frac{10V}{50\Omega}$$

$$i = 0.20\ A$$

$$V_{ter} = \varepsilon - i r_{int} = 10V - (.20A)(10\Omega)$$

$$V_{ter} = 10V - 2V = \boxed{8.0V}$$