

DC Circuits

Battery - causes voltage

Resistance - Links voltage & current

$$V = IR$$

$\left\{ \begin{array}{l} \text{current thru the resistor} \\ \text{voltage across the resistor} \end{array} \right.$

Series - no "fork" between components



The same current goes thru each
Charges lose some energy in each.

$$\text{Series: } V_{\text{net}} = V_1 + V_2 + \dots$$

$$= IR_1 + IR_2 + \dots$$

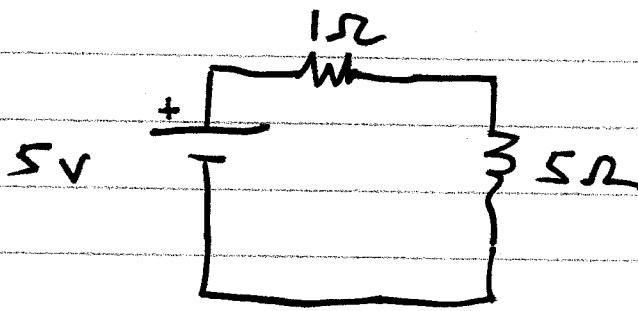
$$= I(R_1 + R_2 + \dots)$$

$$V_{\text{net}} = I R_{\text{eq}}$$

$$\text{Series: } R_{\text{eq}} = R_1 + R_2 + \dots$$

②

Ex:



$$R_{eq} = 1\Omega + 5\Omega = 6\Omega$$

$$I = \frac{V_{net}}{R_{eq}} = \frac{5V}{6\Omega} = 0.87 A$$

Across each part

$$V_1 = IR_1 = 0.87 V$$

$$V_5 = IR_5 = 4.13 V$$

This can model a battery w/ internal resistance

$$R_{int} = 1\Omega$$

$$R_{ext} = 5\Omega$$

$$V_{tot} = V_{out} + IR_{int}$$

Full EMF
of batt

Operating
Voltage

Wasted

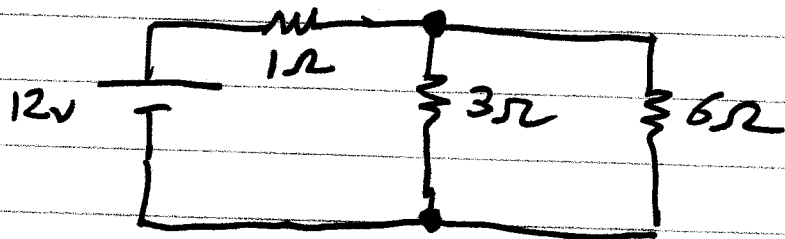
$$(5V) = (4.13V) + (0.87V)$$

EMF = Voltage = Electromotive Force

③

Parallel Circuit

- A parallel section starts with a fork in the wire & ends when the wires come back together.



The 3Ω and 6Ω are in parallel!

$$I_{\text{tot}} = I_3 + I_6$$

$$V_3 = V_6$$

A given charge gains 12V in the battery.

It loses some voltage in the 1Ω resistor.

Then it loses the rest of its voltage in

Either the 3Ω

Or the 6Ω .

Parallel Equivalent R :

$$I_{\text{tot}} = I_1 + I_2 + \dots$$

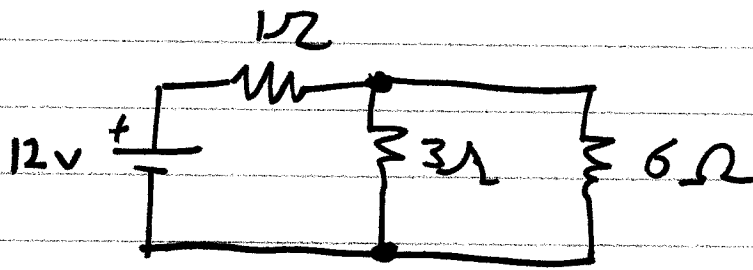
$$= V/R_1 + V/R_2 + \dots$$

$$= V \left(\frac{1}{R_1} + \frac{1}{R_2} + \dots \right)$$

$$I_{\text{tot}} = V/R_{\text{eq}}$$

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

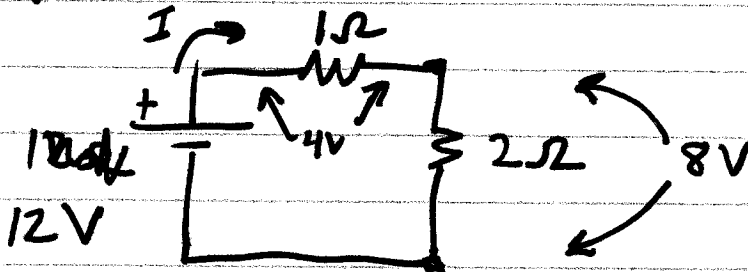
④



Equip of 3Ω and 6Ω :

$$R_{36} = \left(\frac{1}{3} + \frac{1}{6}\right)^{-1} = 2\Omega$$

Equip Circuit



$$I = \frac{12V}{3\Omega} = 4A$$

$$\uparrow 1\Omega + 2\Omega$$

The same 4A flows thru the batt in the original circuit.

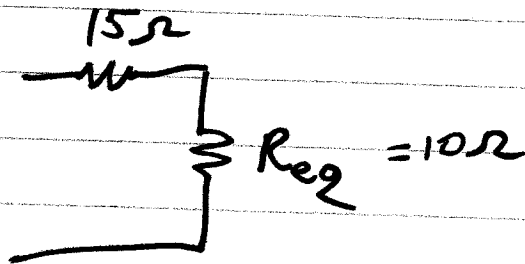
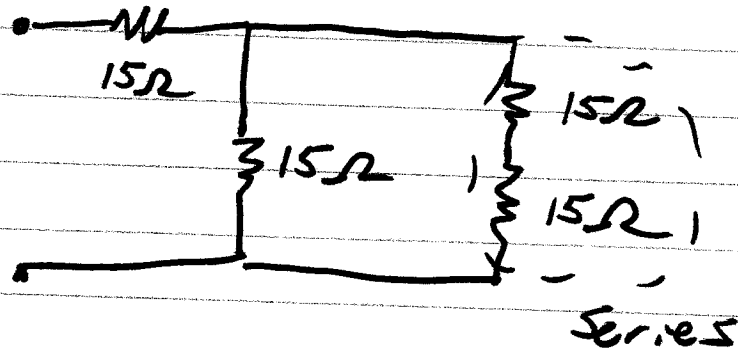
$$V_1 = 4V$$

$$V_3 = 8V = V_6$$

$$I_3 = \frac{8V}{3\Omega} = 2.67A$$

$$I_6 = \frac{8V}{6\Omega} = 1.33A$$

(E)



More Complicated Circuits: Kirchoff's Laws

Current: At a junction

$$\sum I_{in} = \sum I_{out}$$

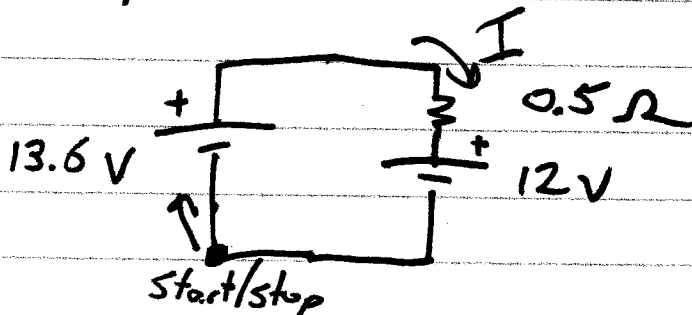
Voltage: For any Loop:

$$\sum_{loop} \Delta V = 0$$

$$\sum_{loop} V_{rises} = \sum_{loop} V_{drops}$$

⑥

Battery Charger



We can follow a loop around the circuit:

Alternator : $\Delta V = +13.6 \text{ V}$

Resistance : $\Delta V = -IR = -I(0.5\Omega)$
negative because voltage drops
across ~~the~~ a resistor.

Battery : $\Delta V = -12 \text{ V}$

$$\sum_{\text{loop}} \Delta V = 0 \rightarrow (13.6\text{V}) - I(0.5\Omega) - (12\text{V}) = 0$$

$$I = \frac{13.6 - 12}{0.5\Omega} = 3.2 \text{ A}$$