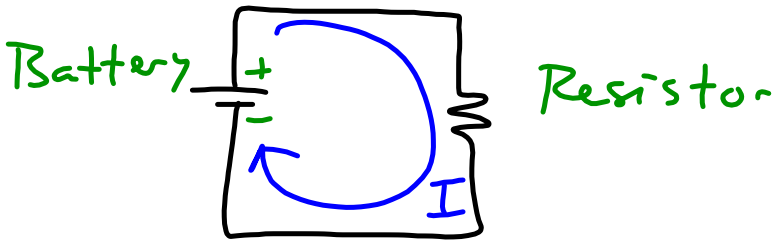
Circuits



I → conventional current, from + to −

(Amperes → A)

R → resistance Ohms (Ω)

V → volts Volts (V)

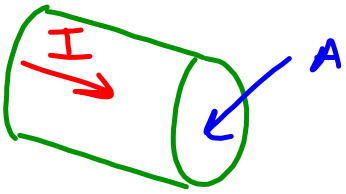
Resistance

$$R = \frac{\rho l}{A}$$

ρ → resistivity

l → length

A → cross-sectional area



Current

$$I = N e v_d A$$

A → cross-sectional area

v_d → drift velocity

e → charge of electron

N → number of charge carriers per unit volume

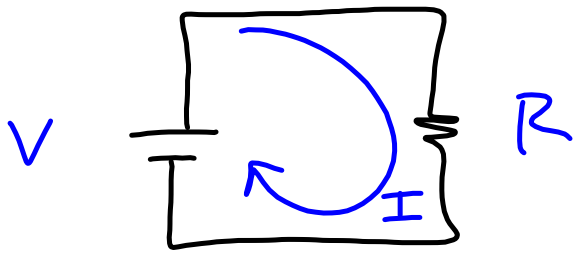
$$I = \frac{dQ}{dt}$$

$$\vec{E} = \rho \vec{J}$$

$\vec{E}$: electric field

$\vec{J}$: current density

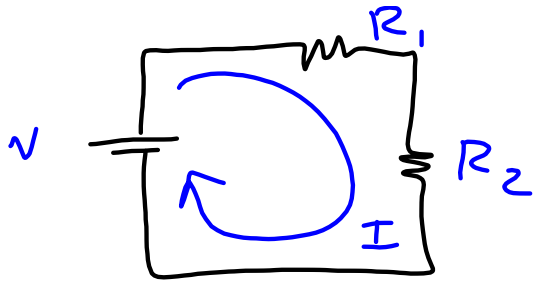
ρ: resistivity



$$P = IV = I^2R = \frac{V^2}{R}$$

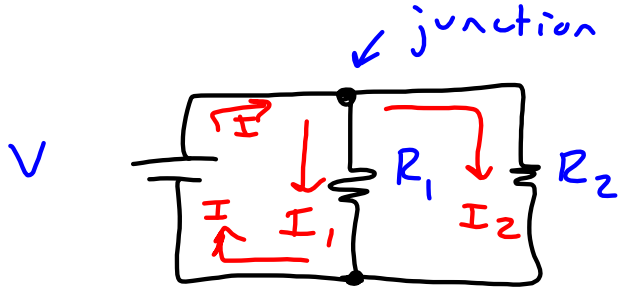
Ohm's Law: $V = IR$

- True for Ohmic materials
- False for non-Ohmic materials



$$R_{eq} = R_1 + R_2 + \dots$$

↳ equivalent resistance



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

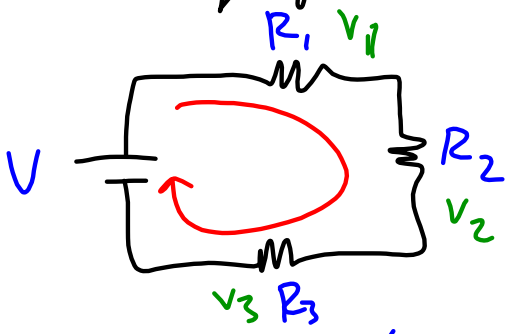
Kirchhoff's Rules:

1. Current into a junction equals current out of a junction.

Junction Rule $I = I_1 + I_2$

2. Voltage lost is equal to the voltage gained in a loop.

Loop Rule

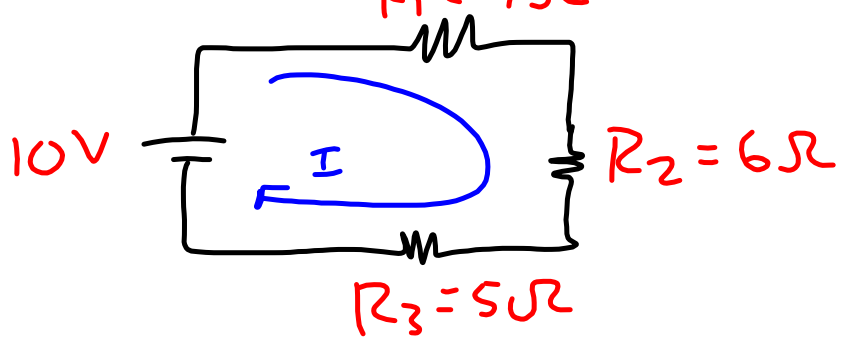


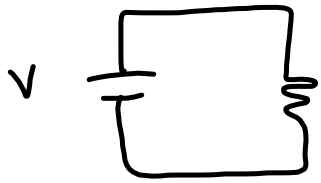
$$[+V - V_1 - V_2 - V_3 = \emptyset]$$ conservation of energy!

$$\Sigma V = \emptyset$$

PRACTICE → Find all I's, V's, R's, P's

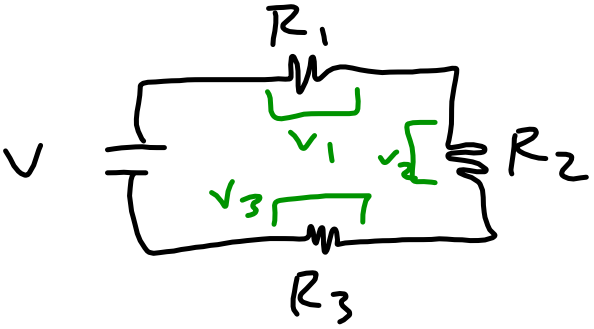
1)





$R_{eq} = 15\Omega$

$I = \frac{V}{R} = 0.66\,A$



$V_1 = IR_1 = 2.67\,V$

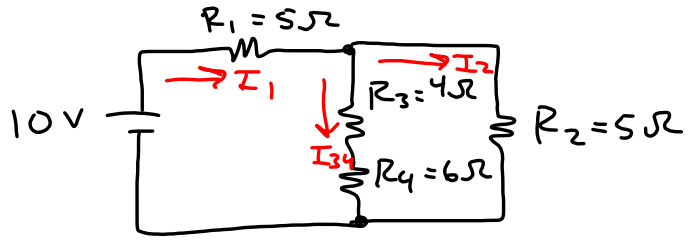
$V_2 = IR_2 = 4\,V$

$V_3 = IR_3 = 3.33\,V$

$P_1 = IV_1 = 1.78\,W$

$P_2 = IV_2 = 2.69\,W$

$P_3 = IV_3 = 2.22\,W$

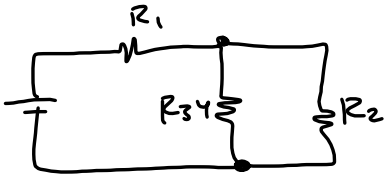


V_1

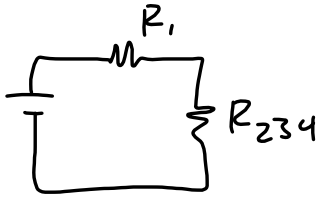
I_1

R_1

P_1

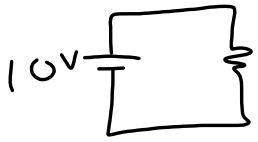


$R_{34} = 10\Omega$



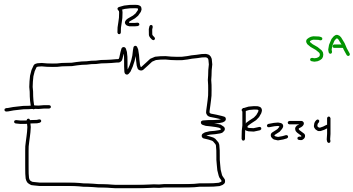
$$\frac{1}{R_{234}} = \frac{1}{R_2} + \frac{1}{R_{34}}$$

$R_{234} = 3.33\Omega$



$R_{eq} = R_1 + R_{234} = 8.33\Omega$

$$I = \frac{V_{Battery}}{R_{eq}} = 1.2\ A$$



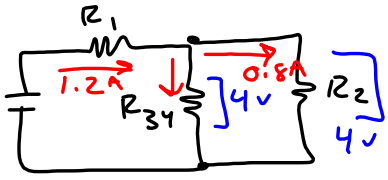
SAME CURRENT!

$I_1 = 1.2A$

$I_{234} = 1.2A$

$V_1 = I_1 R_1 = 6.0\ V$

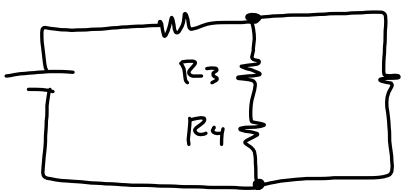
$V_{234} = I_{234} R_{234} = 4.0V$



Voltage is equal for parallel components!

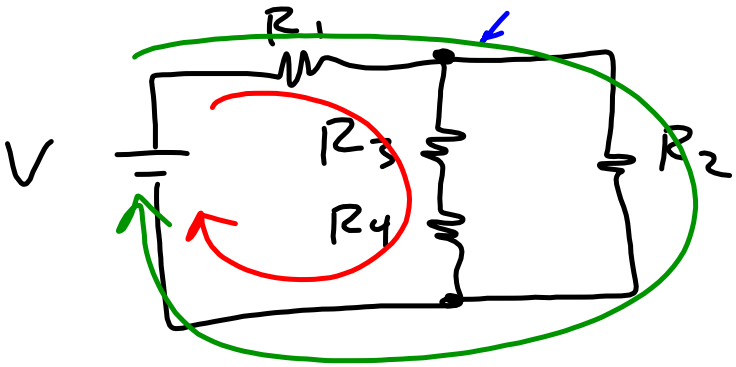
$$I_2 = \frac{V_2}{R_2} = 0.8\ A$$

$$I_{34} = \frac{V_{34}}{R_{34}} = 0.4A$$



$V_3 = I_{34} R_3 = 1.6\ V$

$V_4 = I_{34} R_4 = 2.4\ V$



$$I_1 - I_{34} - I_2 = \emptyset$$

$$V - I_1 R_1 - I_{34} R_{34} = \emptyset$$

$$V - I_1 R_1 - I_2 R_2 = \emptyset$$