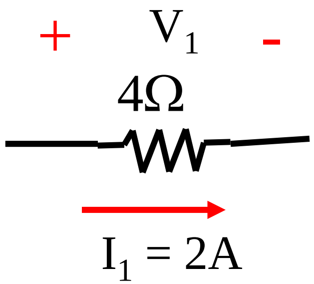
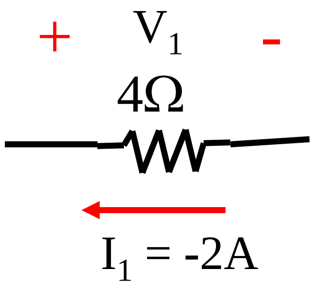


$$V_1 = +I_1R$$

$$V_1 = +(2A)(4\Omega)$$

$$V_1 = +8v$$

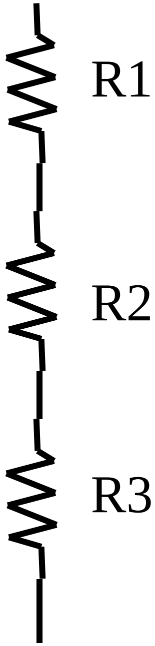


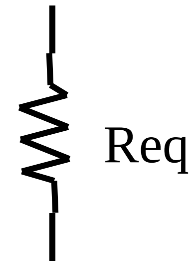
$$V_1 = -I_1R$$

$$V_1 = -(-2A)(4\Omega)$$

$$V_1 = +8v$$

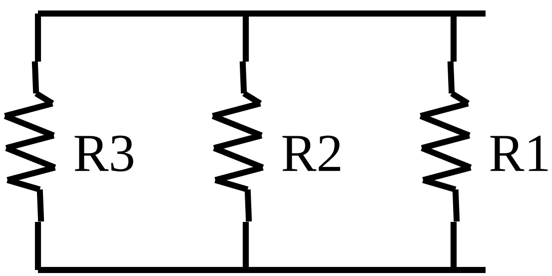
Series

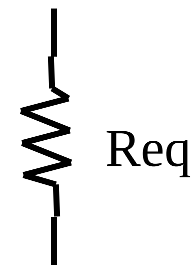




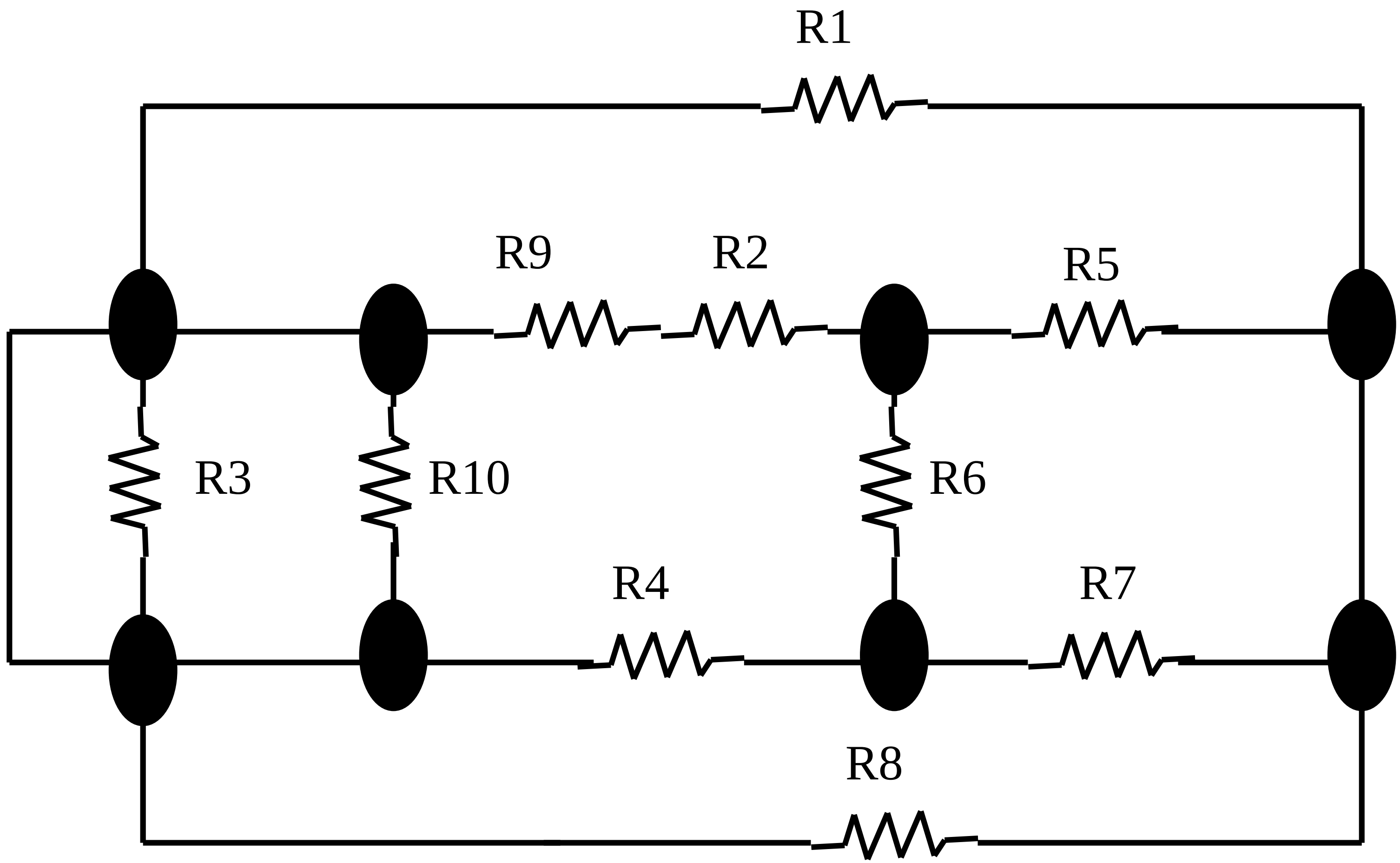
$$\boxed{R_{eq} = R1 + R2 + R3}$$

Parallel



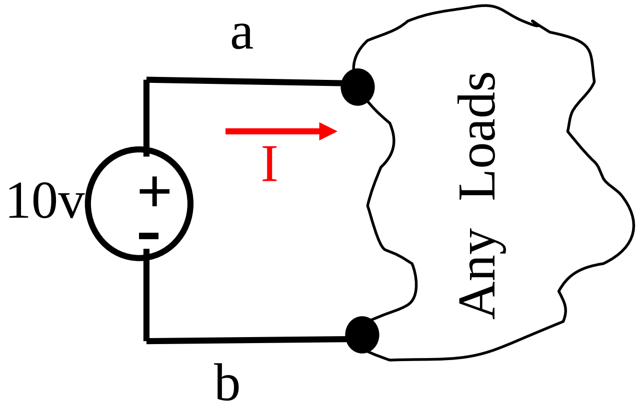


$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}}$$



R2, R9 -	R2, R5 -	R5, R7 -	R1, R8 -
R4, R7 -	R6, R7 -	R3, R10 -	R3, R8 -

Ideal Voltage Source

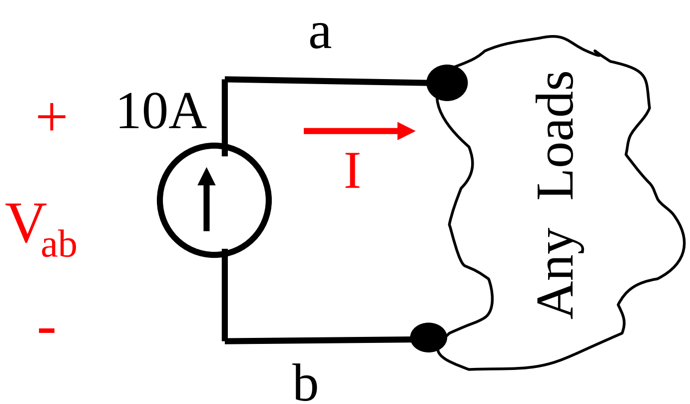


V_{ab} = **?**

I = **?**

Ideal Current Source

V_{ab} = **?**



I = **?**

- **Kirchhoff's Current Law (KCL)**
- **Kirchhoff's Voltage Law (KVL)**

Kirchhoff's Current Law (KCL)

$$\Sigma\, I = 0 \qquad \underline{\textit{OR}} \qquad \sum I_{in} = \sum I_{out}$$

-- at any nodes

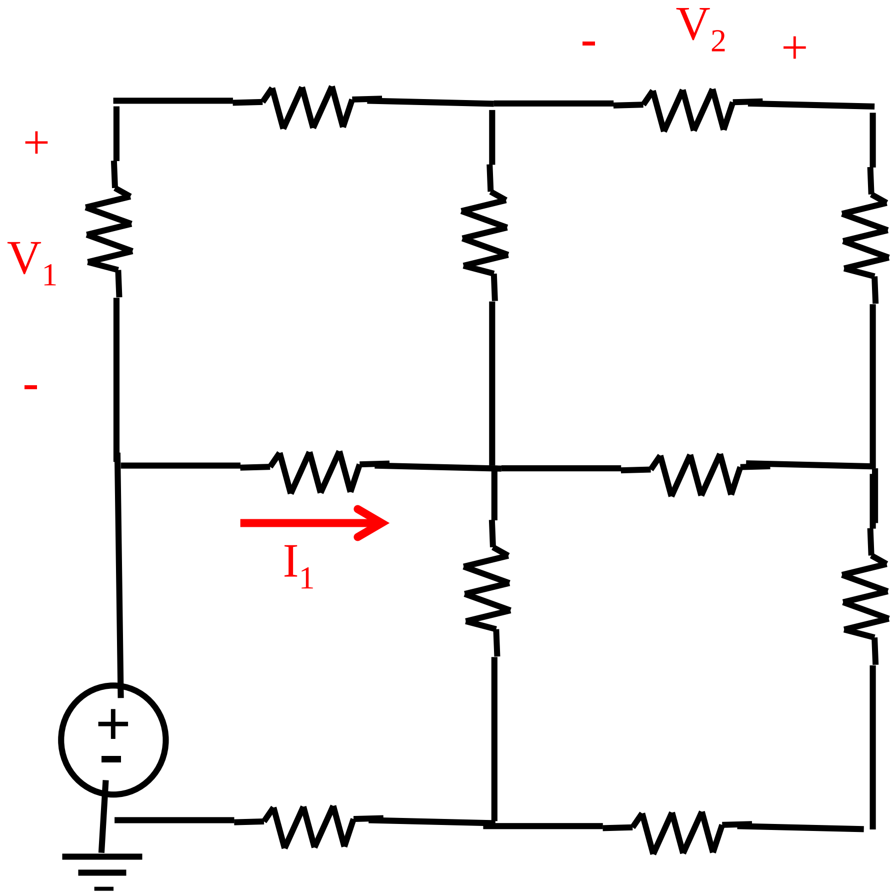
-- conservation of charge

Kirchhoff's Voltage Law (KVL)

$$\Sigma\, V = 0$$

-- at any closed loop

-- conservation of energy



$V_1 = ?$

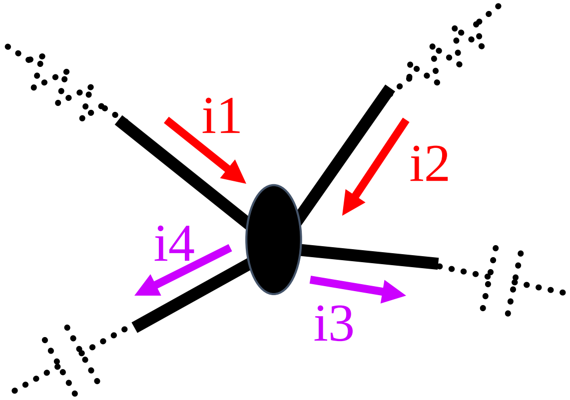
$V_2 = ?$

$I_1 = ?$

$V = IR$

$\sum I = 0$

$\sum V = 0$



Kirchhoff's Current Law (KCL)

Case I

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

i1 + i2 = i3 + i4

in *out*

Case II

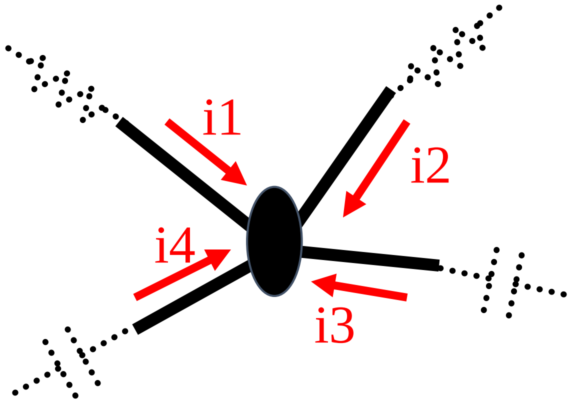
$$\Sigma I = 0$$

i1 + i2 + **(-1)**i3 + **(-1)**i4 = 0

Case III

(-1)i1 + **(-1)**i2 + i3 + i4 = 0

Ex.



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

$$\underbrace{i1 + i2 + i3 + i4}_{in} = \underbrace{?}_{out}$$

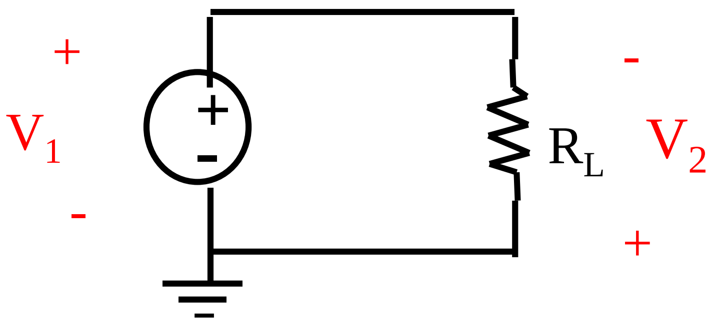
---

i1 + i2 + i3 + i4 = 0

(+3) + (+2) + (-4) + (-1) = 0

(-3) + (-2) + (+4) + (+1) = 0

Kirchhoff's Voltage Law (KVL)

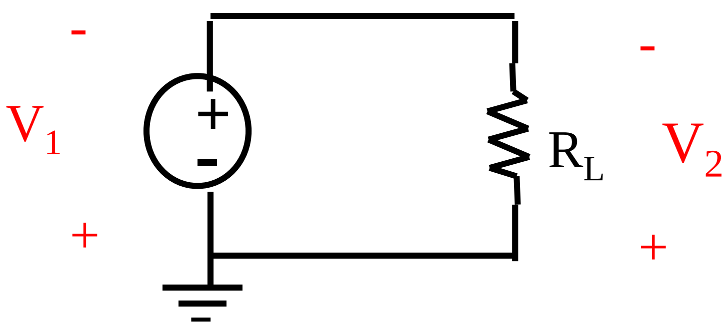


$$\sum V = 0$$

$$V_1 + V_2 = 0$$

V_1 = (+ve or -ve) **?**

V_2 = (+ve or -ve) **?**

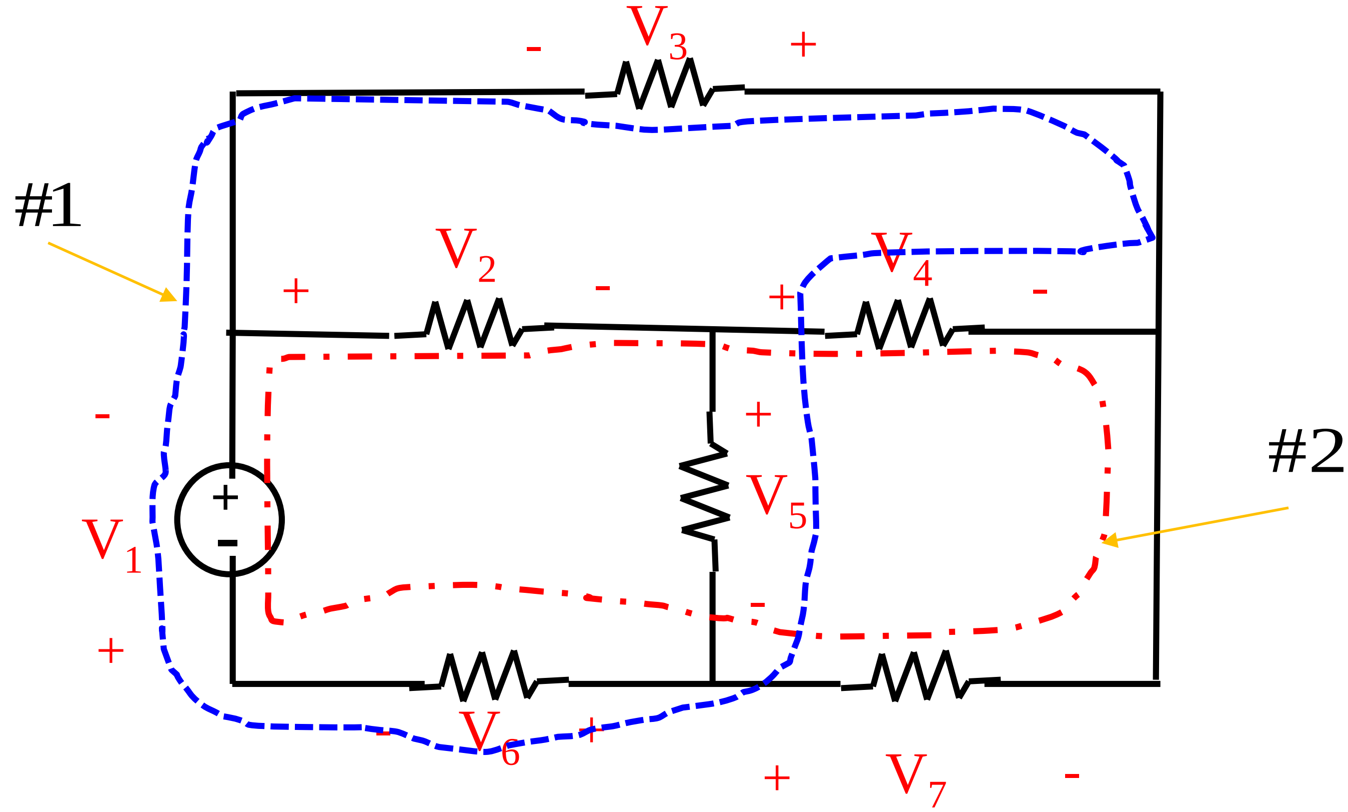


$$\sum V = 0$$

$$(-1)V_1 + V_2 = 0$$

V_1 = (+ve or -ve) **?**

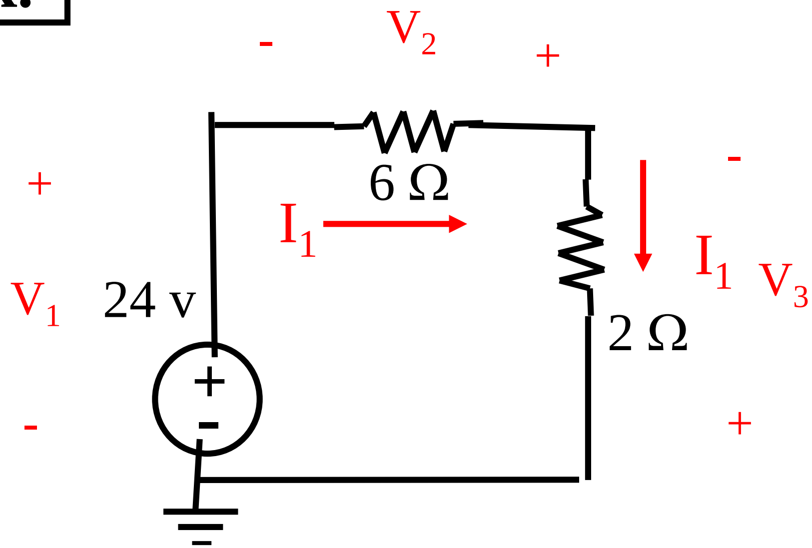
V_2 = (+ve or -ve) **?**

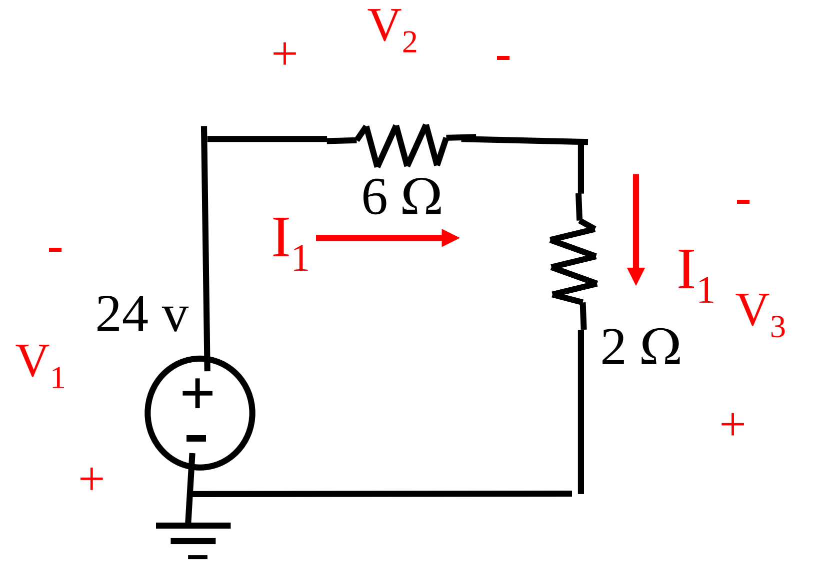


#1 $$+(-V_1)+(+V_3)+(+V_4)+(-V_5)+(-V_6)=0$$

#2 $$+(-V_1)+(-V_2)+(-V_4)+(+V_7)+(-V_6)=0$$

Ex.





$$\sum V = 0$$

$$\mathbf{V}_1 + \mathbf{V}_2 + \mathbf{V}_3 = 0$$

$+(24 - 0) + (-I_1)(6) + (-I_1)(2) = 0$

$24 = 8\ I_1$

$I_1 = 3$

$$\sum V = 0$$

$$(-\mathbf{V}_1) + (-\mathbf{V}_2) + \mathbf{V}_3 = 0$$

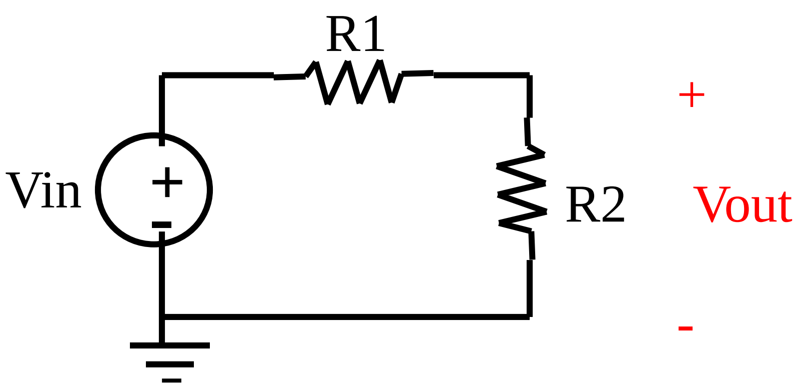
$+[\ -(0 - 24)] + [-(I_1)(6)] + (-I_1)(2) = 0$

$24 = 8\ I_1$

$I_1 = 3$

Useful Equations

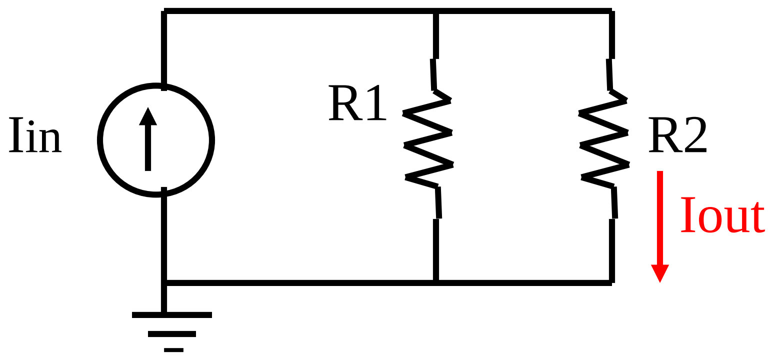
Voltage Divider Circuit



Using KVL

$$\boxed{V_{out} = \frac{R2}{R1 + R2} V_{in}}$$

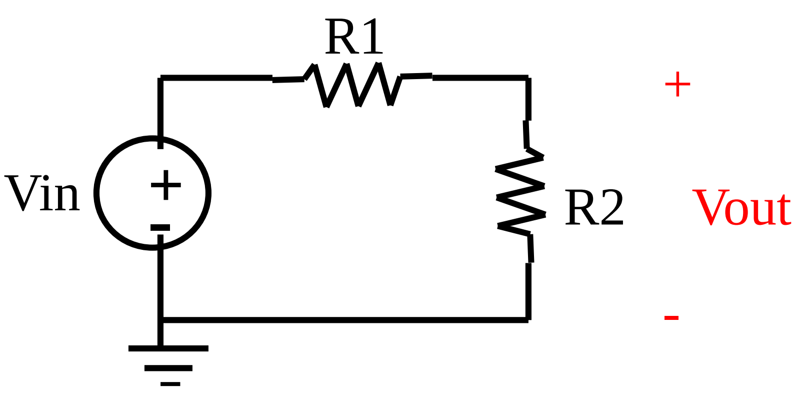
Current Divider Circuit



Using KCL

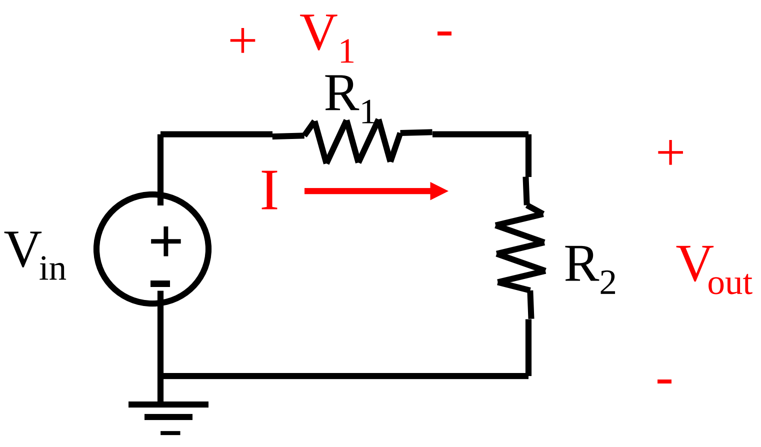
$$\boxed{I_{out} = \frac{R1}{R1 + R2} I_{in}}$$

Voltage Divider Circuit



Using KVL

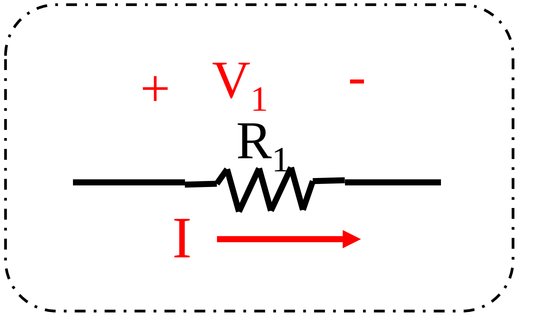
$$\boxed{V_{out} = \frac{R2}{R1 + R2} V_{in}}$$

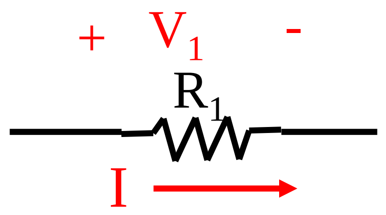


$$\sum V = 0$$

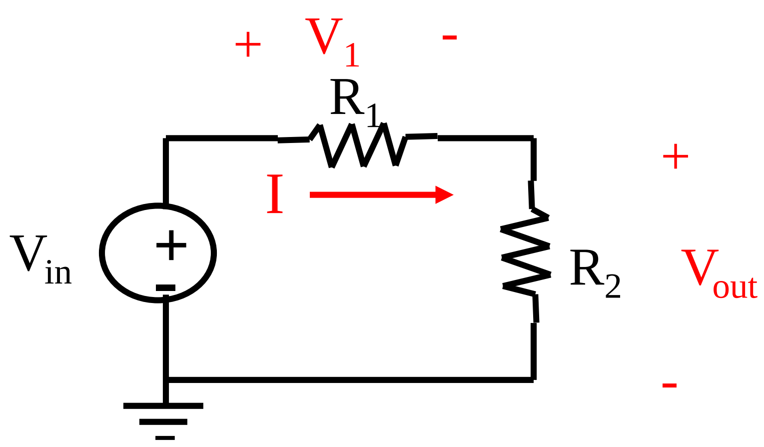
$$V_{in} - V_1 - V_{out} = 0$$

$$V_{out} = V_{in} - V_1$$





$$V_1 = I \cdot R_1$$

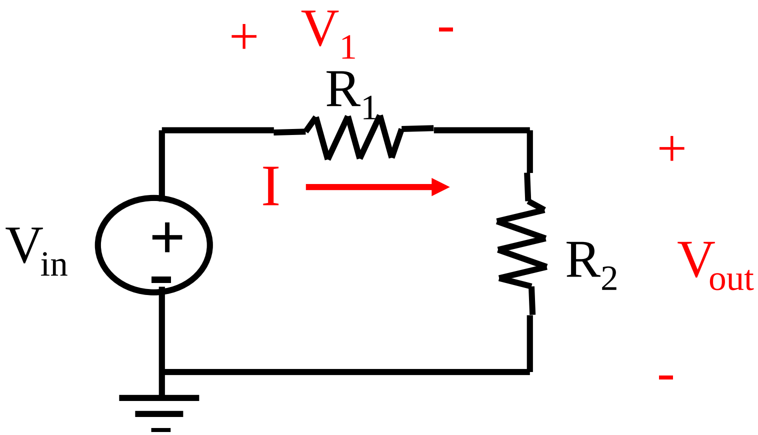


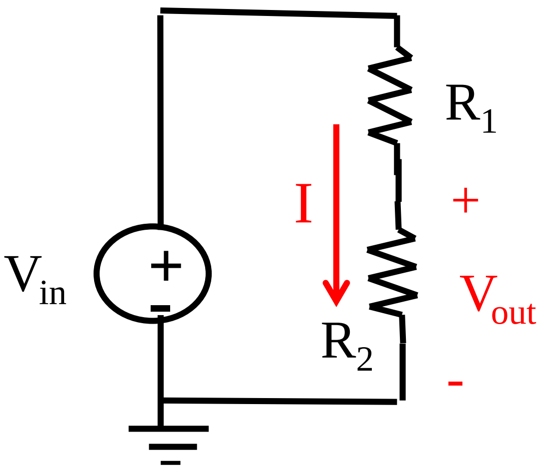
$$\sum V = 0$$

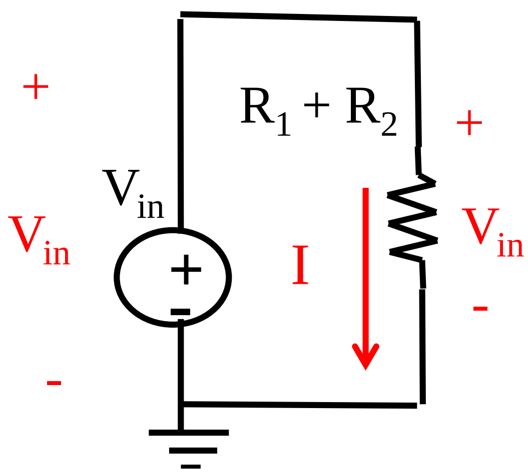
$$V_{in} - V_1 - V_{out} = 0$$

$$V_{out} = V_{in} - V_1$$

$$V_{out} = V_{in} - I \cdot R_1$$



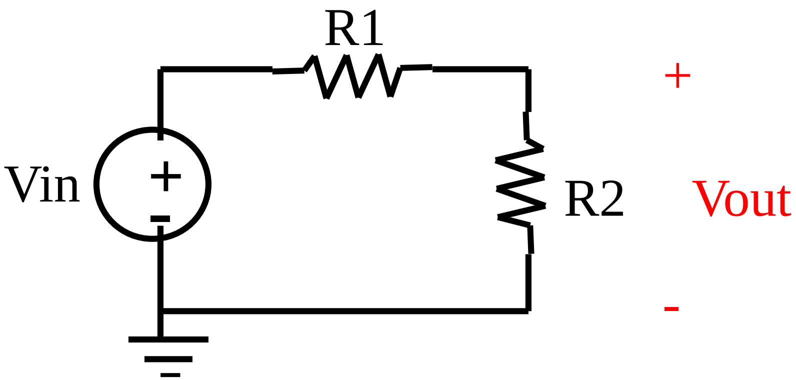




V_{in}= I· $(R_1 + R_2)$

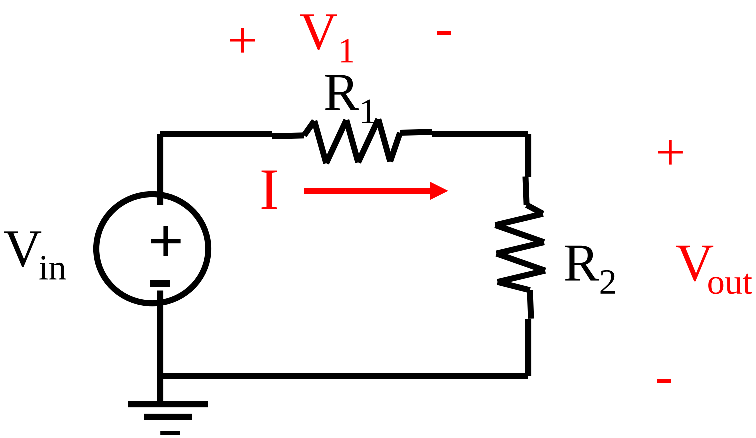
$$I = \frac{V_{in}}{R_1 + R_2}$$

Voltage Divider Circuit



Using KVL

$$\boxed{V_{out} = \frac{R2}{R1 + R2} V_{in}}$$



$$\sum V = 0$$

$$V_{in} - V_1 - V_{out} = 0$$

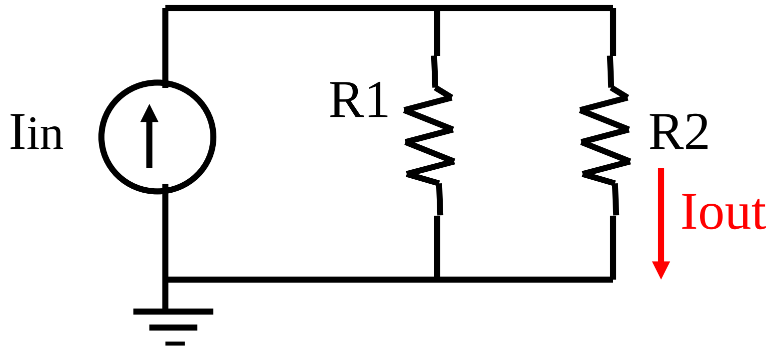
$$V_{out} = V_{in} - V_1$$

$$V_{out} = V_{in} - I \cdot R_1$$

$$V_{out} = V_{in} - \left(\frac{V_{in}}{R_1 + R_2}\right) \cdot R_1$$

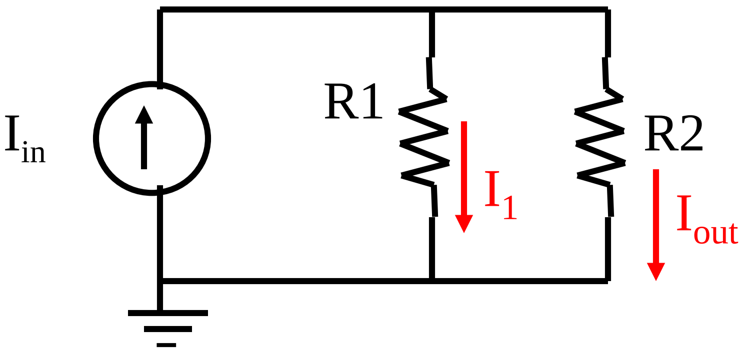
$$\boxed{V_{out} = \left(\frac{R_2}{R_1 + R_2}\right) \cdot V_{in}}$$

Current Divider Circuit



Using KCL

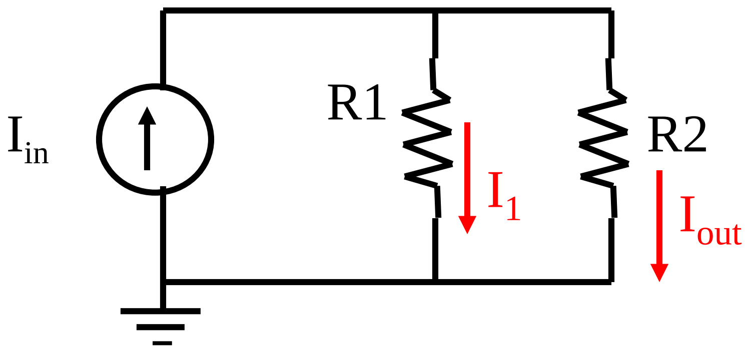
$$\boxed{\mathbf{I}_{\mathbf{out}} = \frac{\mathbf{R}1}{\mathbf{R}1 + \mathbf{R}2}\mathbf{I}_{\mathbf{in}}}$$

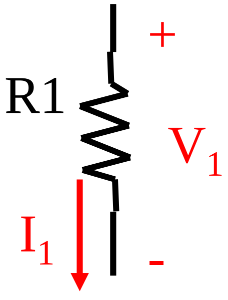


$I_{out} = ?$

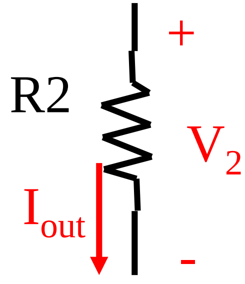
$$\sum \mathbf{I} = 0$$

$$(\mathbf{I}_{\mathbf{in}}) + (-\mathbf{I}_1) + (-\mathbf{I}_{\mathbf{out}}) = 0$$





$$V_1 = I_1 \cdot R1$$



$$V_2 = I_{out} \cdot R2$$

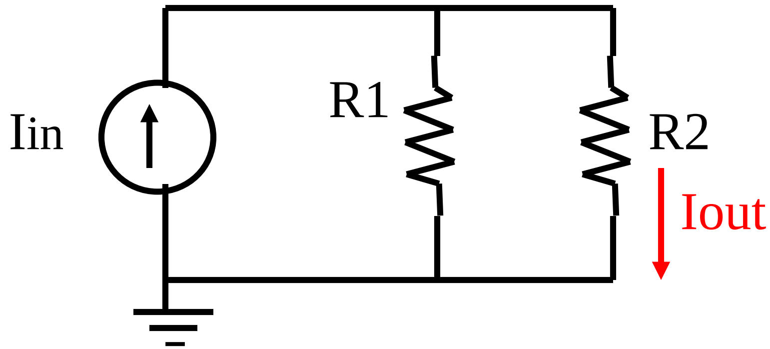
$$V_1 = V_2$$

$$\mathbf{I}_1 \cdot \mathbf{R}1 = \mathbf{I}_{\mathbf{out}} \cdot \mathbf{R}2$$

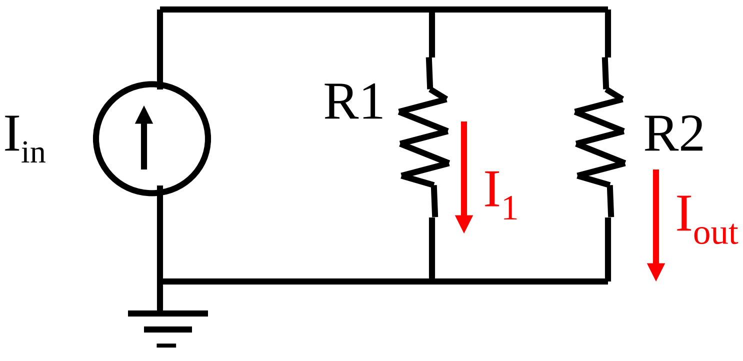
$$\mathbf{I}_1 = \frac{\mathbf{I}_{\mathbf{out}} \cdot \mathbf{R}2}{\mathbf{R}1}$$

Current Divider Circuit

Using KCL



$$\boxed{I_{out} = \frac{R1}{R1 + R2} I_{in}}$$



$I_{out} = ?$

$$\sum I = 0$$

$$(I_{in}) + (-I_1) + (-I_{out}) = 0$$

$$(I_{in}) + \left(-\frac{I_{out} \cdot R2}{R1}\right) + (-I_{out}) = 0$$

$$\boxed{I_{out} = \frac{R1}{R1 + R2} I_{in}}$$