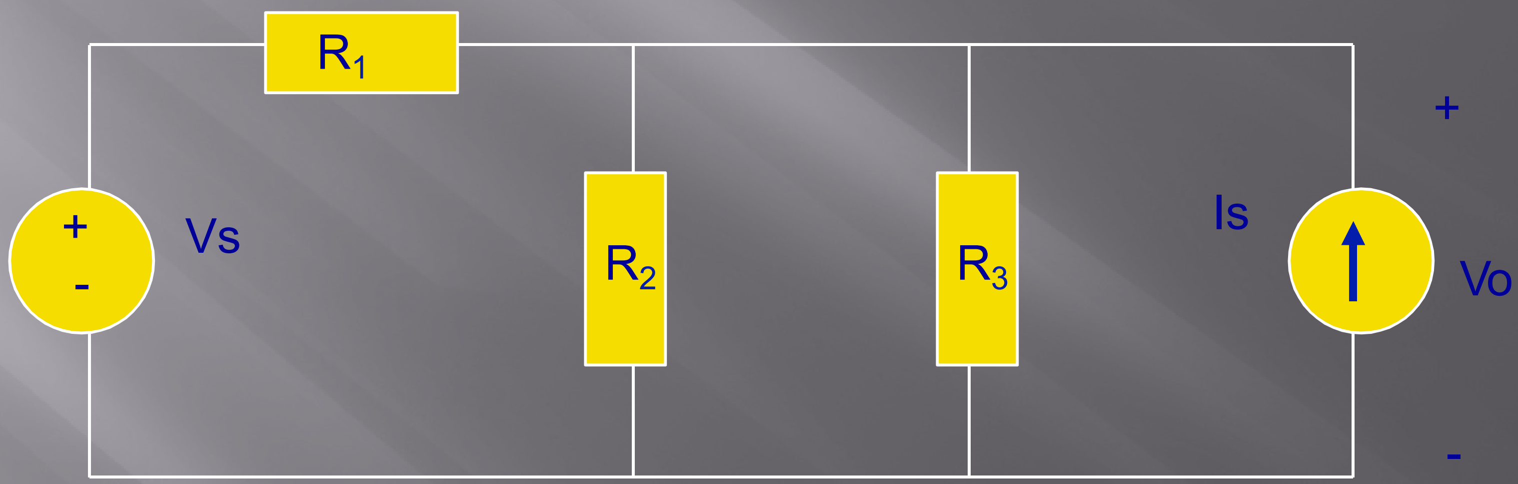
BASIC PRINCIPLES OF COMMUNICATION CIRCUITS

Circuit Definitions

- **Node** – any point where 2 or more circuit elements are connected together
  - Wires usually have negligible resistance
  - Each node has one voltage (w.r.t. ground)
- **Branch (rama)** – a circuit element between two nodes
- **Loop (lazo)** – a collection of branches that form a closed path returning to the same node without going through any other nodes or branches twice

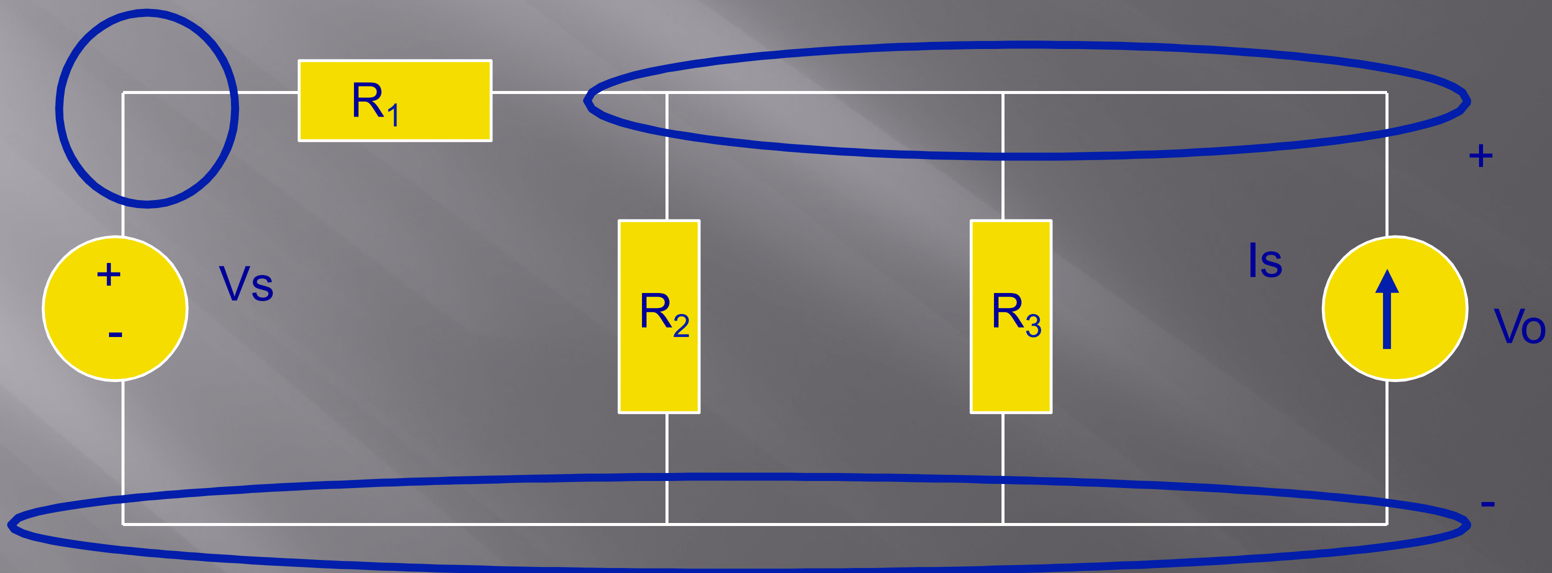
Example

- **How many nodes, branches & loops?**



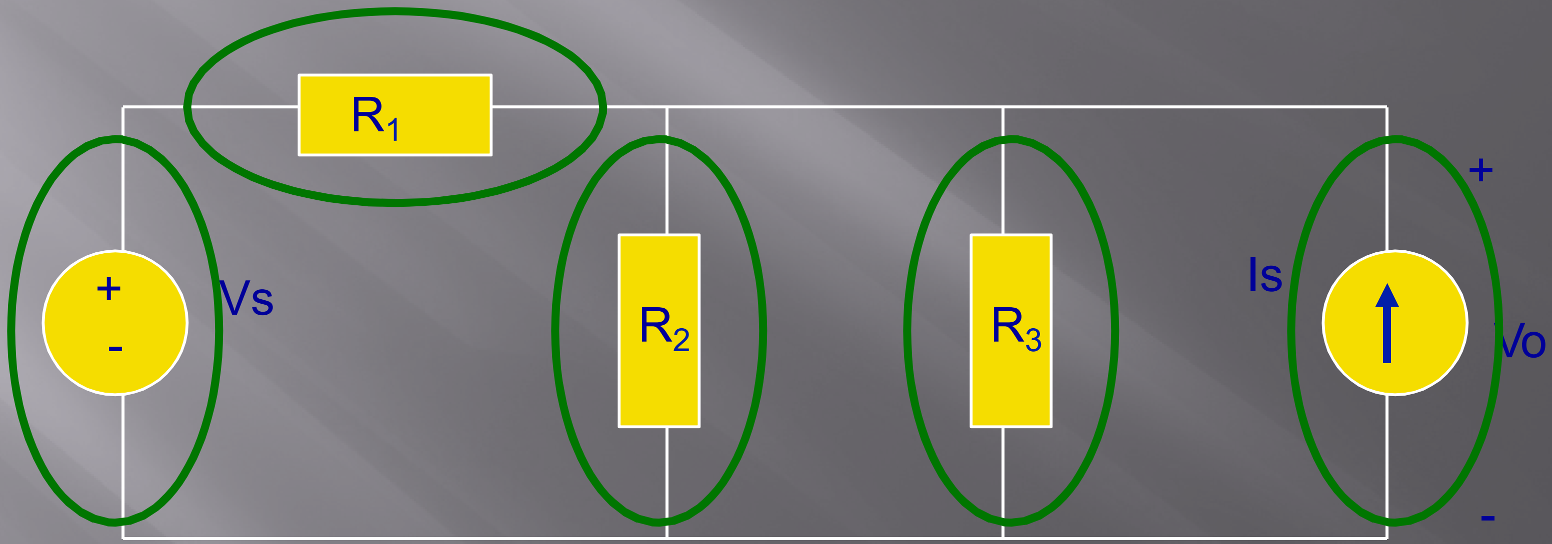
Example

- **Three nodes**



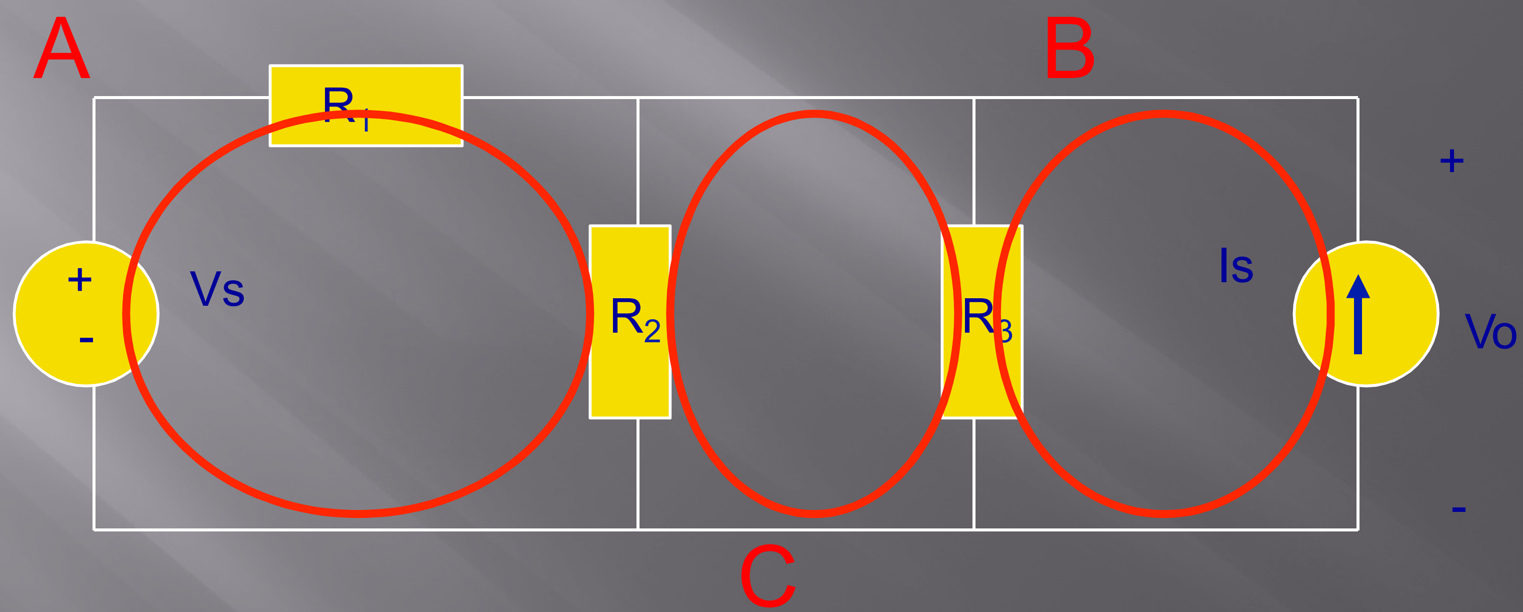
Example

- **5 Branches**



Example

- **Three Loops, if starting at node A**

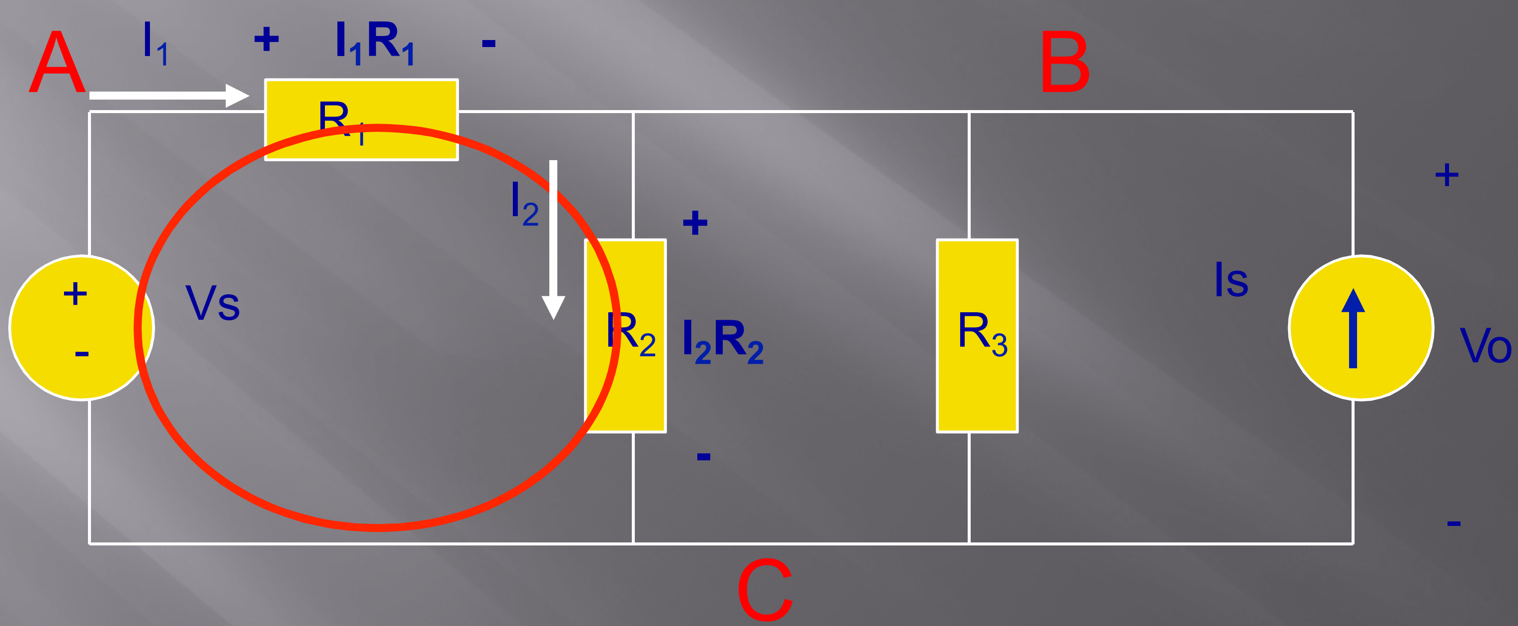


Kirchoff's Voltage Law (KVL)

- The algebraic sum of voltages around each loop is zero
  - Beginning with one node, add voltages across each branch in the loop (if you encounter a + sign first) and subtract voltages (if you encounter a – sign first)
- Σ voltage drops - Σ voltage rises = 0
- Or Σ voltage drops = Σ voltage rises

Example

- **Kirchoff's Voltage Law around 1st Loop**

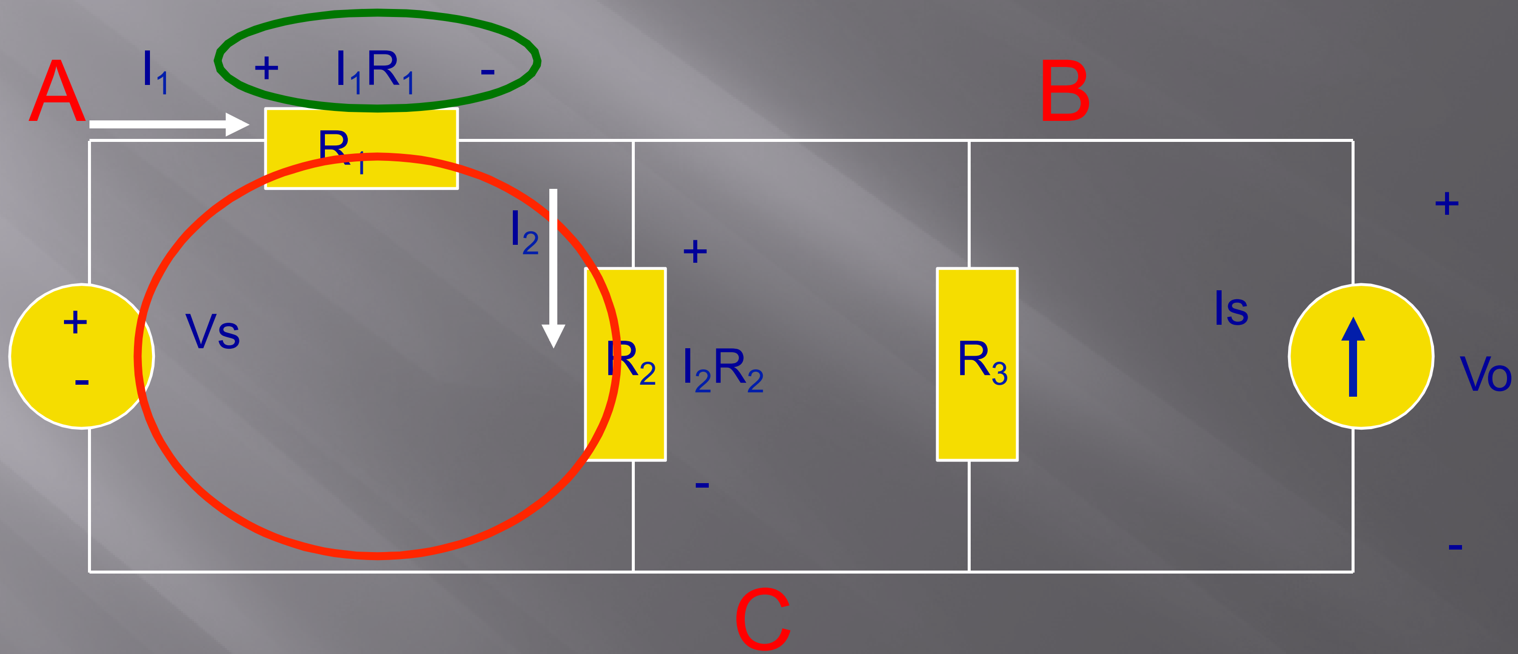


Assign current variables and directions

Use Ohm's law to assign voltages and polarities consistent with passive devices (current enters at the + side)

Example

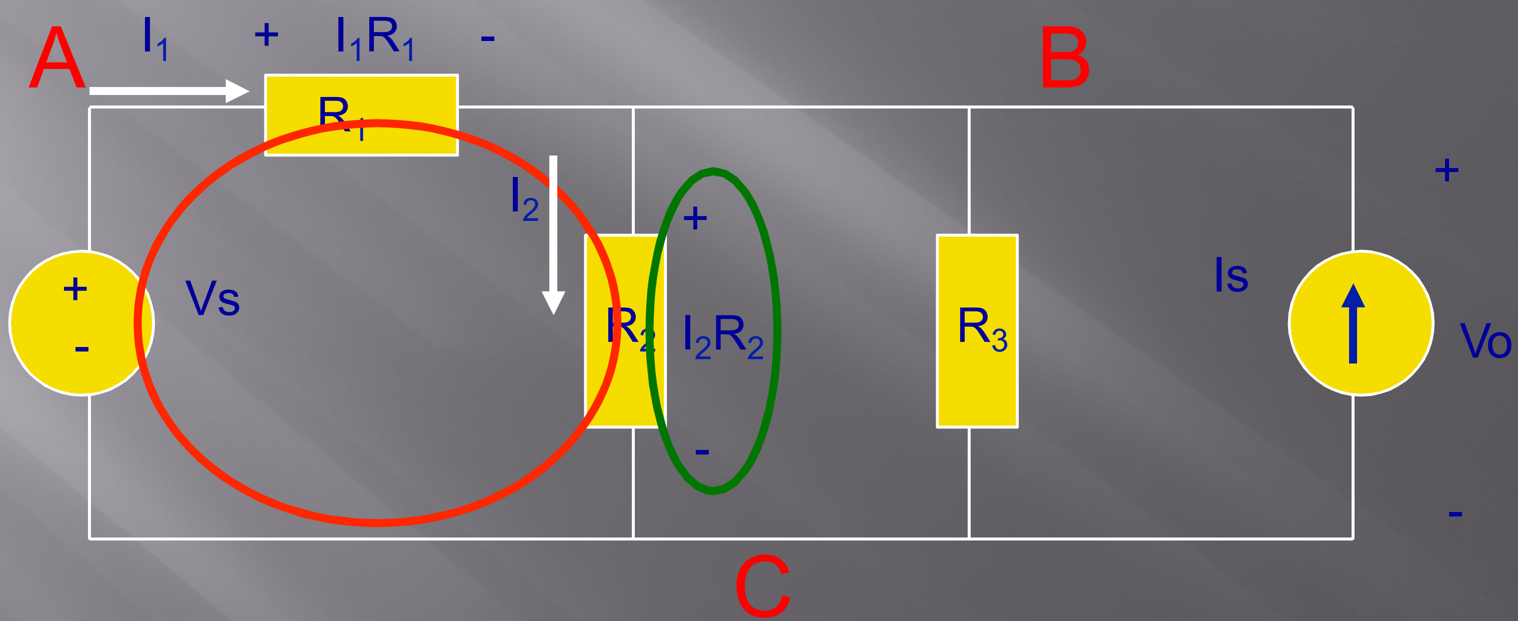
- **Kirchoff's Voltage Law around 1st Loop**



Starting at node A, add the 1st voltage drop: + I_1R_1

Example

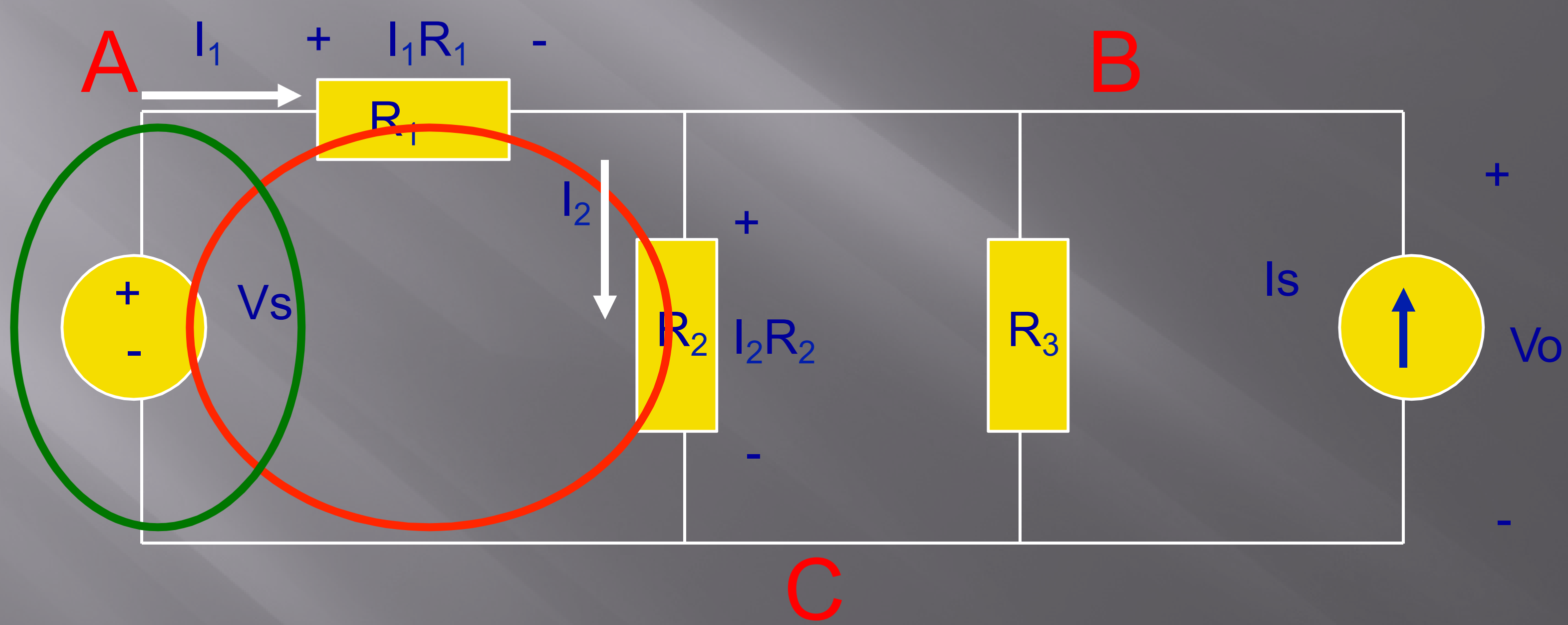
- **Kirchoff's Voltage Law around 1st Loop**



Add the voltage drop from B to C through R_2: $+ I_1R_1 + I_2R_2$

Example

- **Kirchoff's Voltage Law around 1st Loop**



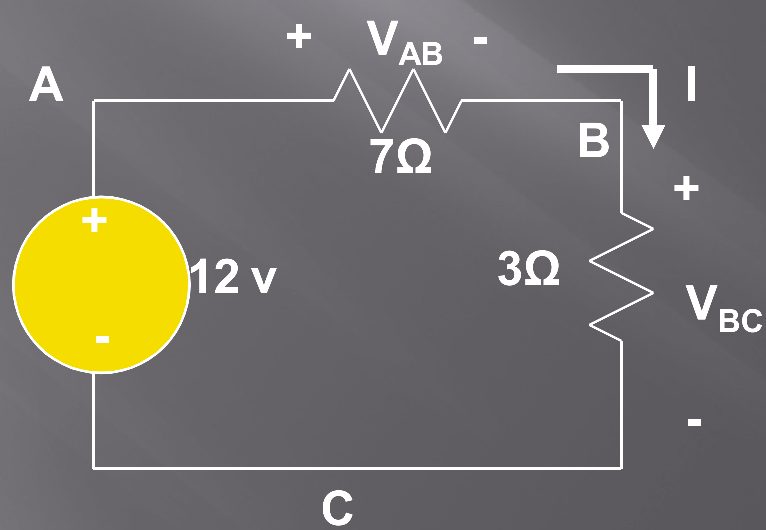
Subtract the voltage rise from C to A through Vs: $+ I_1R_1 + I_2R_2 – Vs = 0$

Notice that the sign of each term matches the polarity encountered 1st

Circuit Analysis

Circuit Analysis

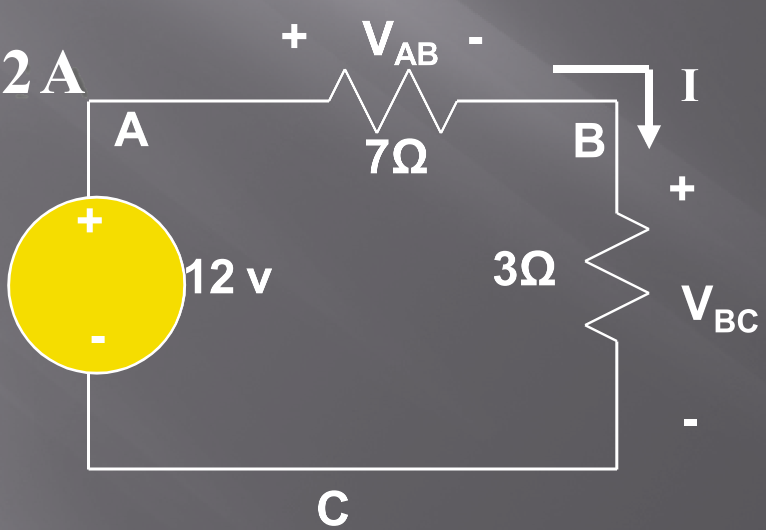
- **When given a circuit with sources and resistors having fixed values, you can use Kirchoff's two laws and Ohm's law to determine all branch voltages and currents**



Circuit Analysis

Circuit Analysis

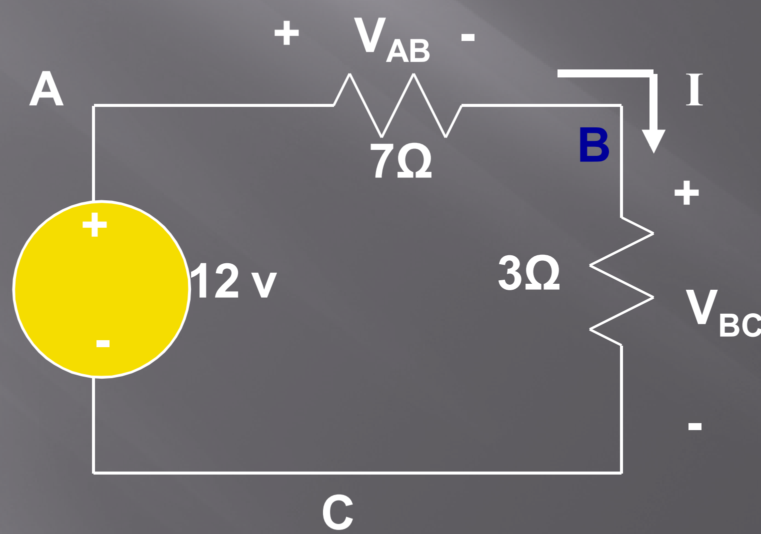
- By Ohm's law: $V_{AB} = I \cdot 7\Omega$ and $V_{BC} = I \cdot 3\Omega$
- By KVL: $V_{AB} + V_{BC} - 12\ v = 0$
- Substituting: $I \cdot 7\Omega + I \cdot 3\Omega - 12\ v = 0$
- Solving: $I = 1.2\,A$



Circuit Analysis

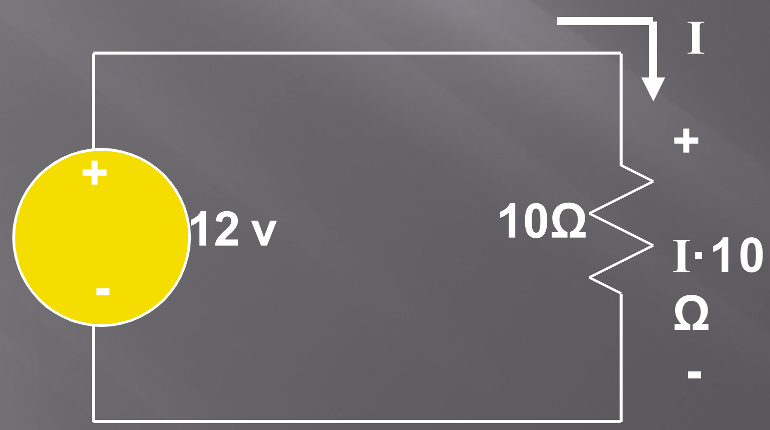
Circuit Analysis

- Since $V_{AB} = I \cdot 7\Omega$ and $V_{BC} = I \cdot 3\Omega$
- And $I = 1.2\ A$
- So $V_{AB} = 8.4\ v$ and $V_{BC} = 3.6\ v$



Series Resistors

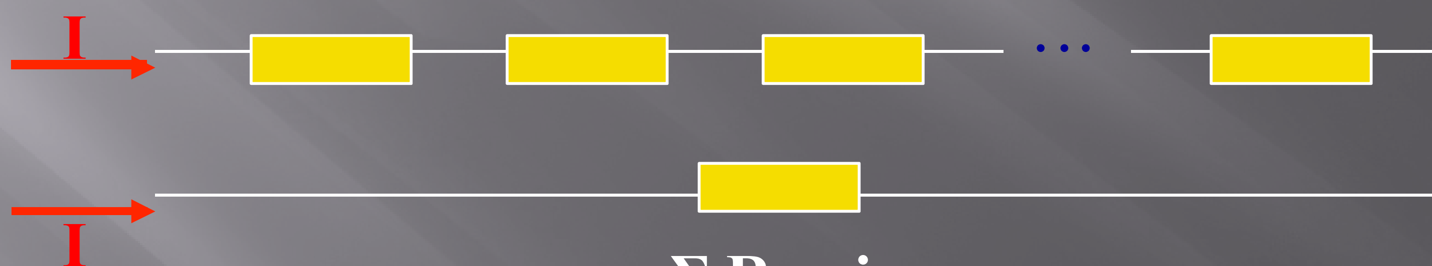
- KVL: $+I \cdot 10\Omega - 12\ v = 0$, So $I = 1.2\ A$
- From the viewpoint of the source, the 7 and 3 ohm resistors in series are equivalent to the 10 ohms



Series Resistors

- To the rest of the circuit, series resistors can be replaced by an equivalent resistance equal to the sum of all resistors

Series resistors (same current through all)



Σ Rseries

Kirchoff's Current Law (KCL)

- The algebraic sum of currents entering a node is zero
  - Add each branch current entering the node and subtract each branch current leaving the node
- Σ currents in - Σ currents out = 0 Or Σ currents in = Σ currents out

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  - Add each branch current entering the node and subtract each branch current leaving the node
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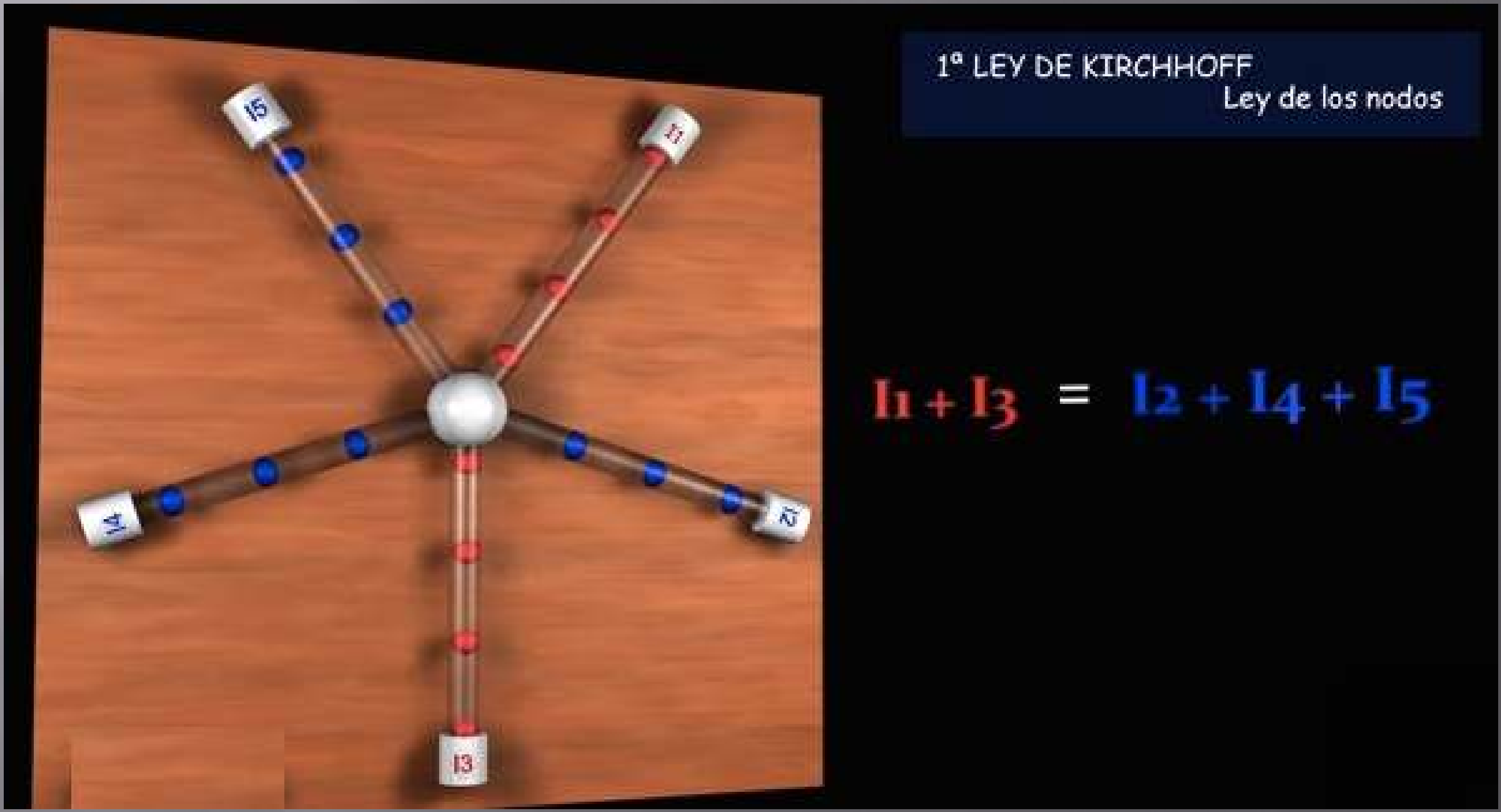
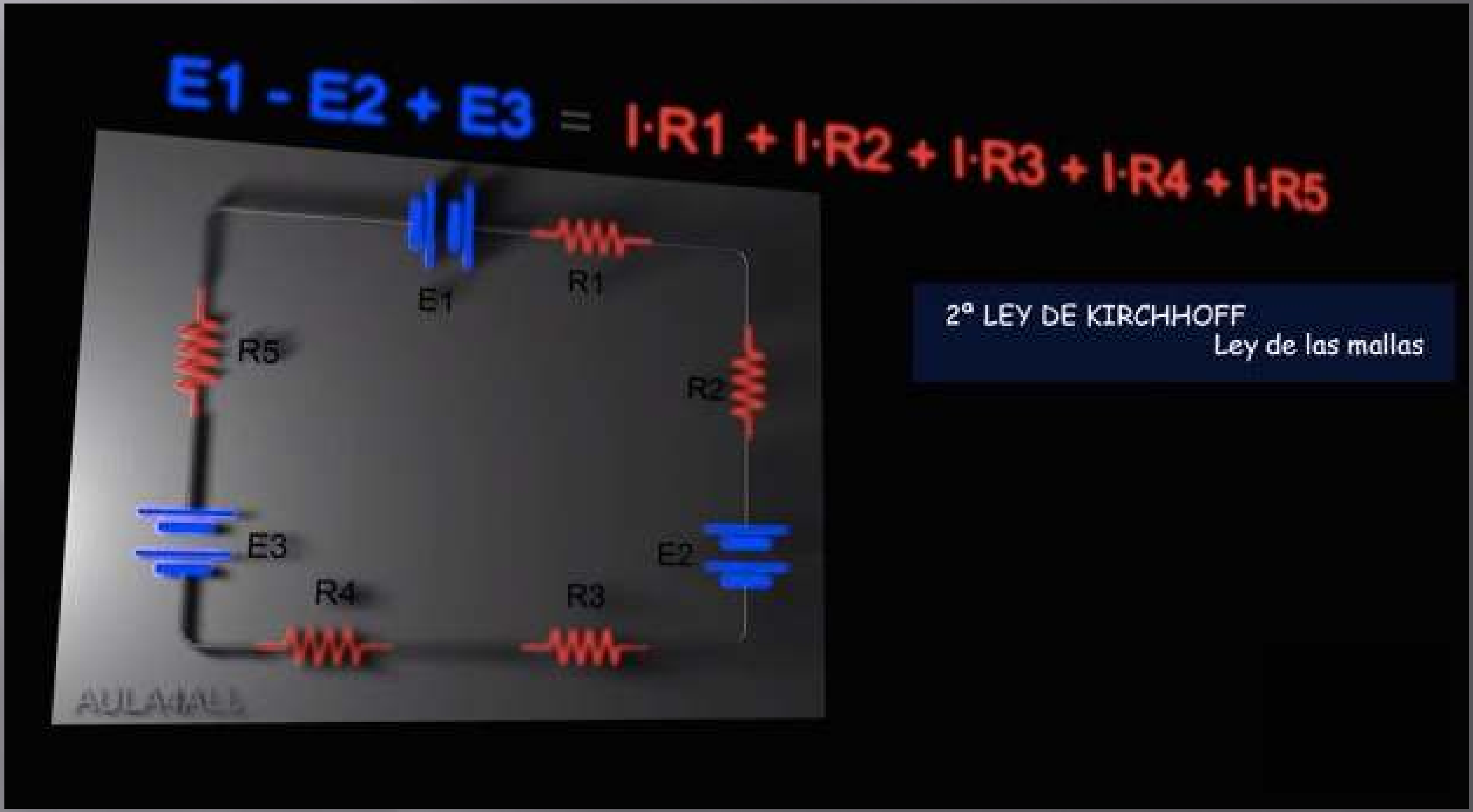
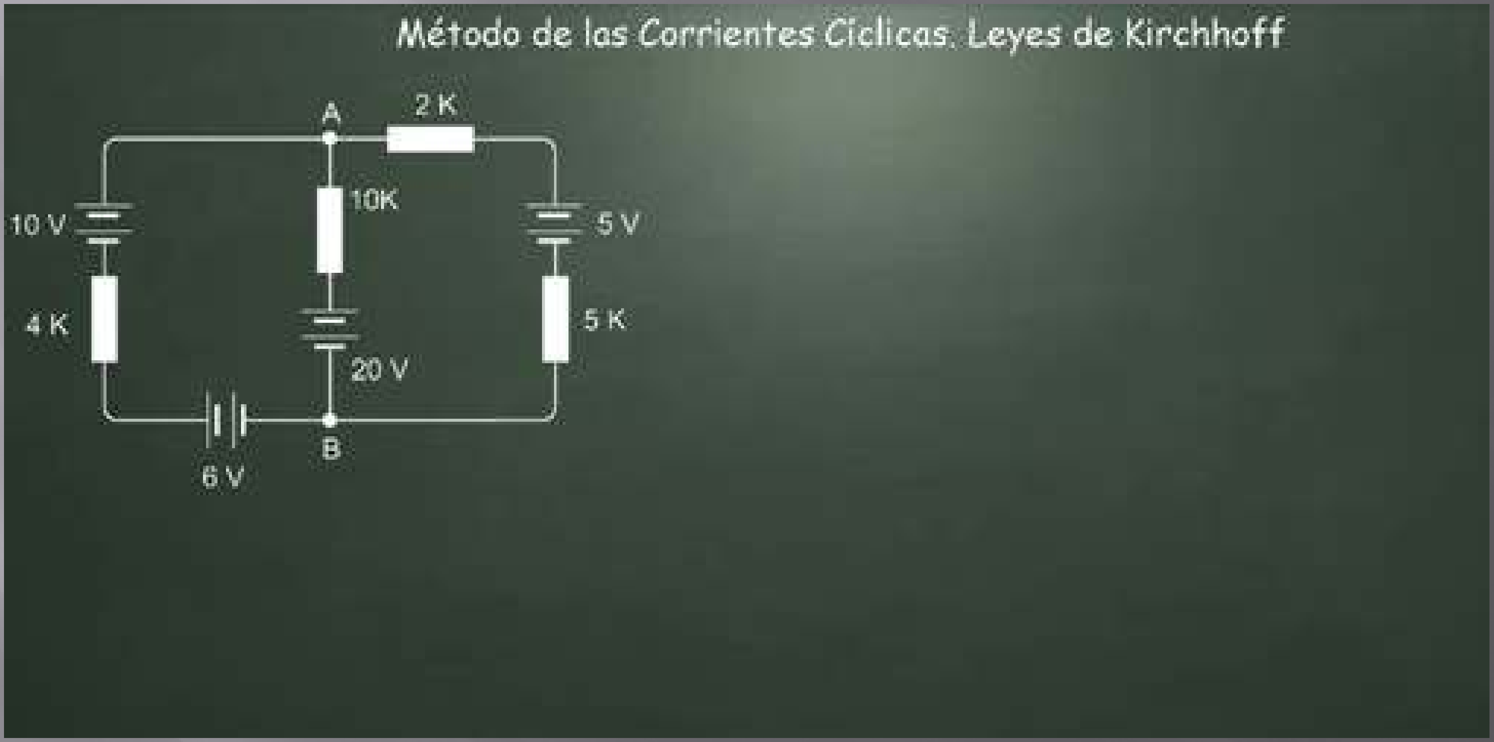
Example



Example

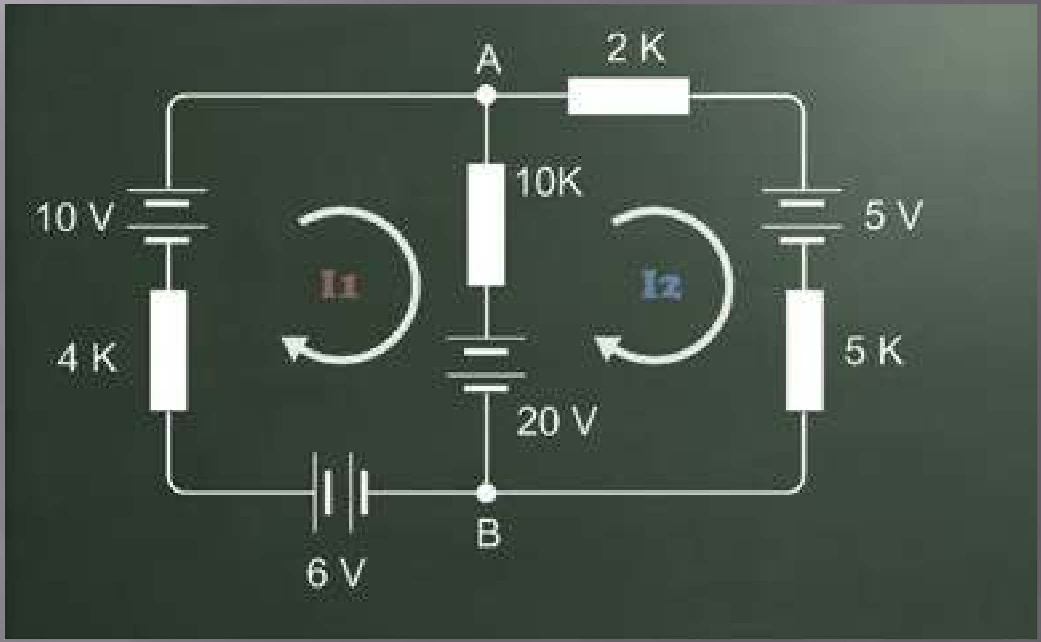

E1 - E2 + E3 = I·R1 + I·R2 + I·R3 + I·R4 + I·R5
E1
R1
R5
R2
E3
E2
R4
R3
2° LEY DE KIRCHHOFF
Ley de las mallas

Example


Método de las Corrientes Cíclicas. Leyes de Kirchhoff
A
2 K
10K
10 V
5 V
4 K
5 K
20 V
B
6 V

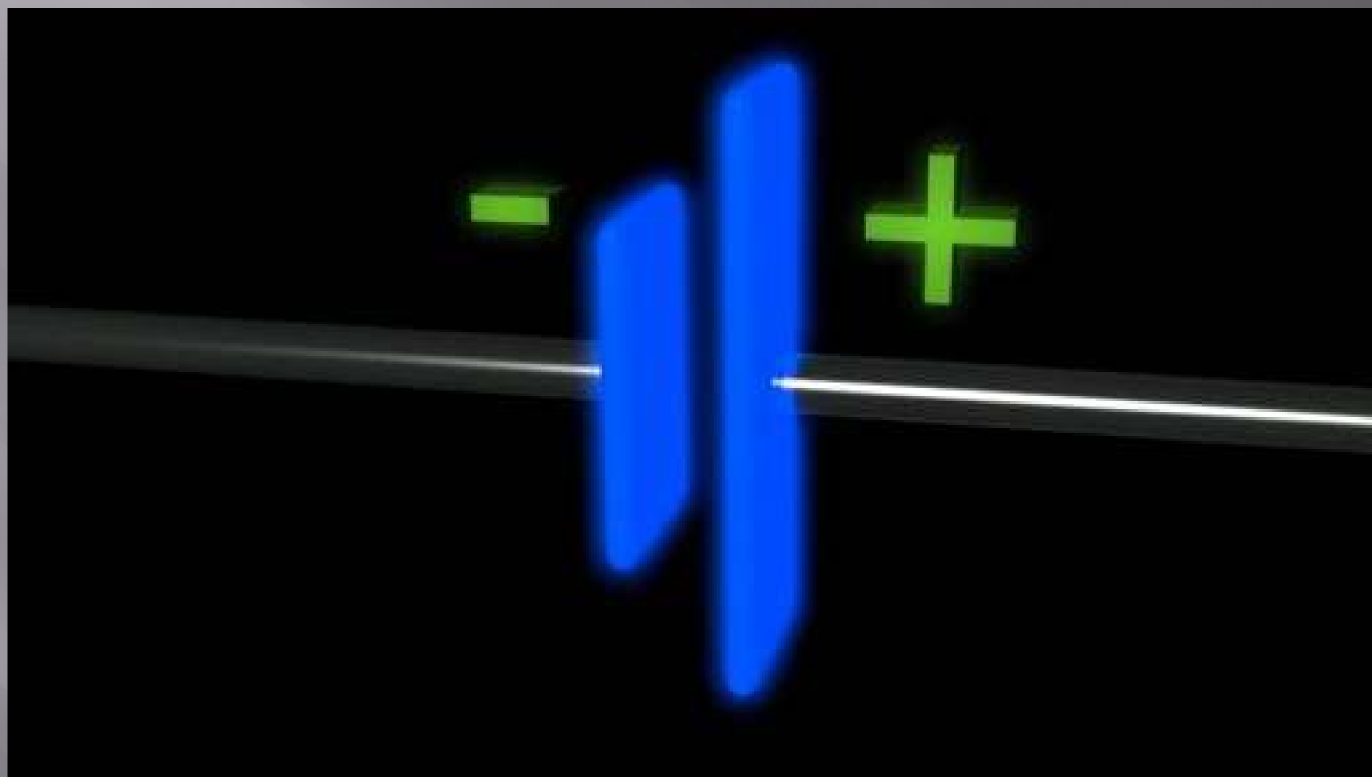
Circuit Analysis

Circuit Analysis



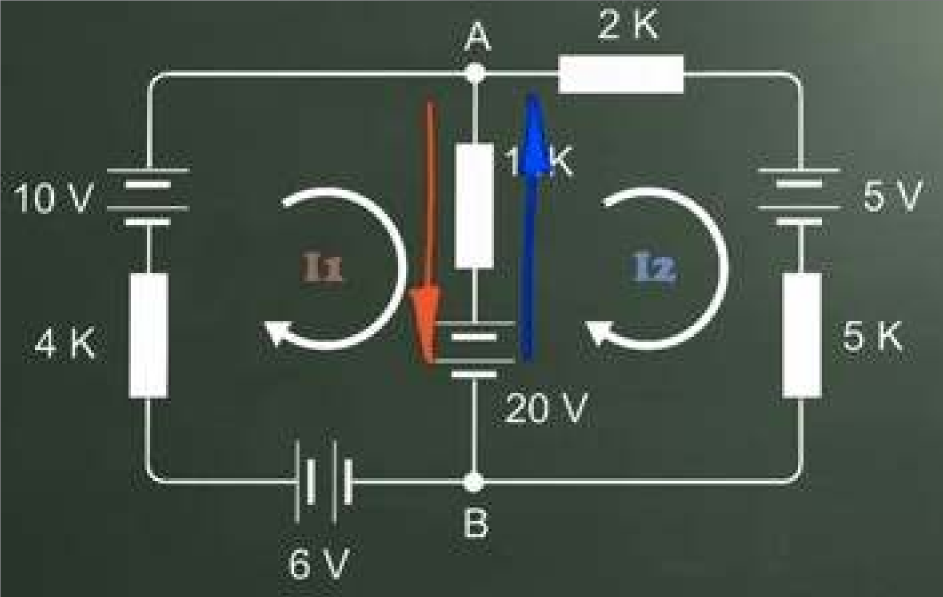
Circuit Analysis

Circuit Analysis



Circuit Analysis

Circuit Analysis



1ª Malla

$10 - 20 + 6 = 4I1 + 10\,(I1 - I2)$

$-4 = 4I1 + 10I1 - 10I2$

$-4 = 14I1 - 10I2$

2ª Malla

$20 - 5 = 10(\,I2 - I1) + 2I2 + 5I2$

$15 = 10I2 - 10I1 + 2I2 + 5I2$

$15 = 17I2 - 10I1$

$-4 = 14I1 - 10I2$

$15 = -10I1 + 17I2$

The second equation multiplied by 1.4

$-4 = 14I1 - 10I2$

$21 = -14I1 + 23{,}8I2$

$-4 = 14I1 - 10I2$

$21 = -14I1 + 23{,}8I2$

$17 = \quad 0 \quad + 13{,}8\,I2$

$$I2 = \frac{17}{13.8} = 1{,}23 \text{ mA.}$$

$-4 = 14I1 - 10\,(1{,}23)$

$-4 = 14I1 - 12{,}3$

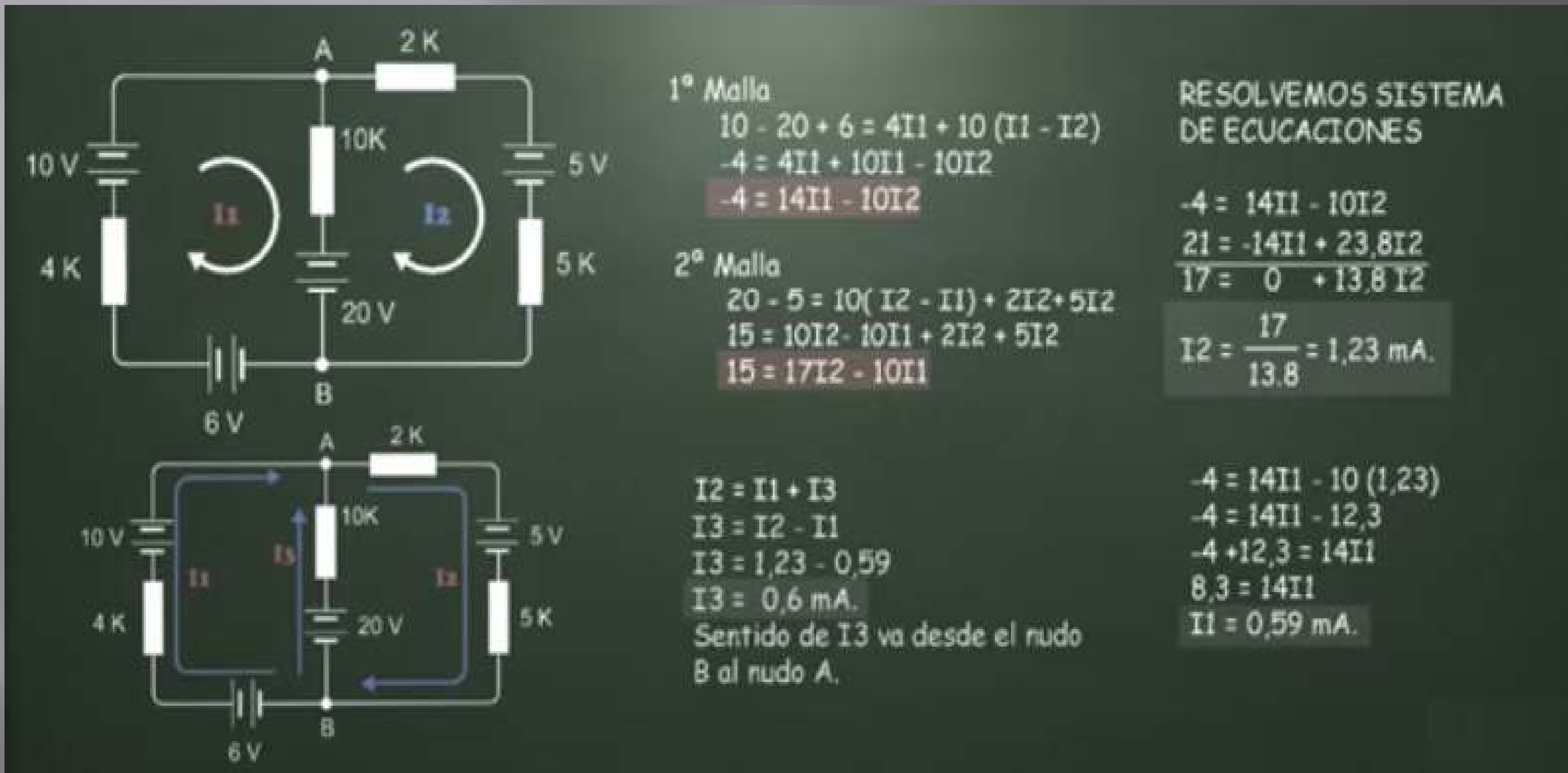
$-4 + 12{,}3 = 14I1$

$8{,}3 = 14I1$

$I1 = 0{,}59$ mA.

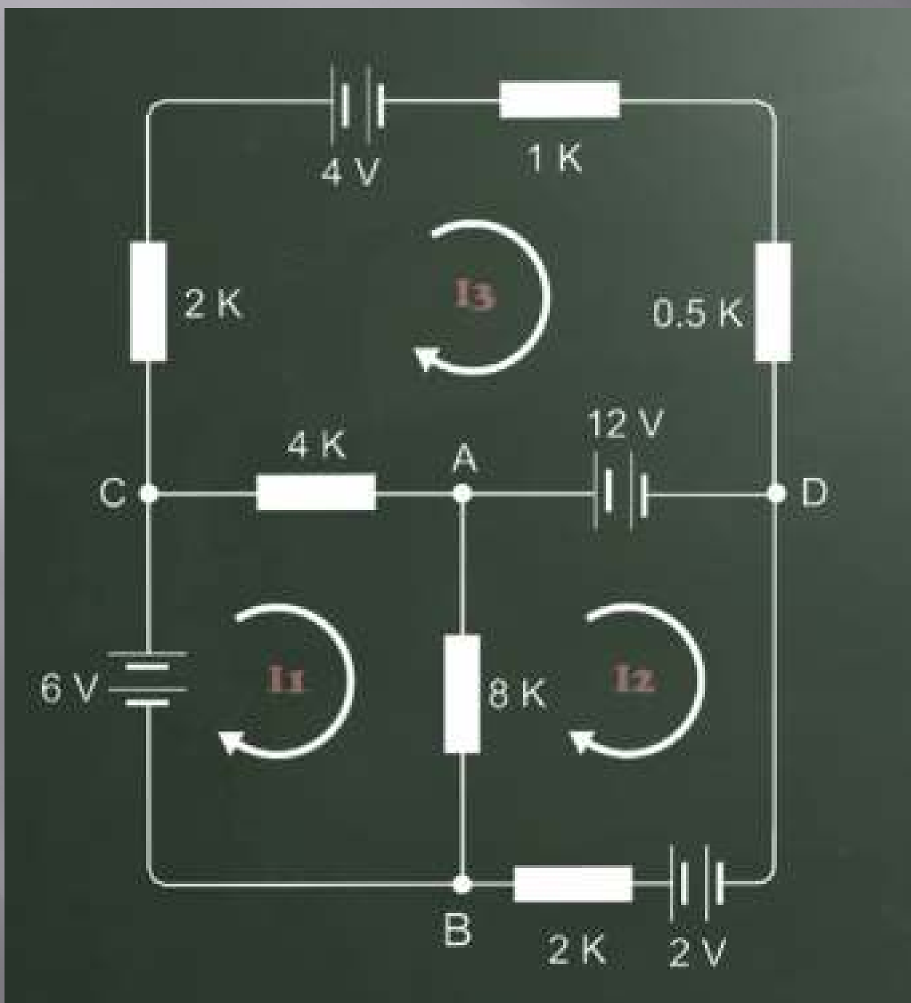
Circuit Analysis

Circuit Analysis



Circuit Analysis

Circuit Analysis



3ª Malla

$12 - 4 = 4(I3 - I1) + 2I3 + I3 + 0{,}5\,I3$

$8 = 4I3 - 4I1 + 3{,}5I3$

$8 = 7{,}5I3 - 4I1$