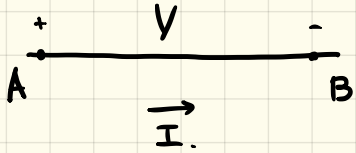
Lecture 3 :

① Wires :



$V = 0$ for any I.

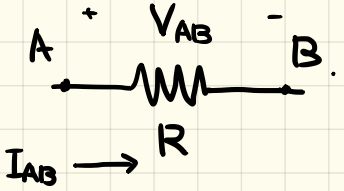
Two points in a circuit connected by a wire are said to be shorted together.

② Resistor : An element that has resistance.

Resistance : Voltage required to push current through an element.

Units : Ohm (Ω)

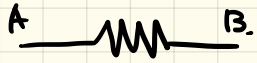
$$1\Omega = \frac{1V}{1A}$$



$V_{AB} = V_A - V_B$.

Ohm's law captures the relationship between the voltage across a register and the current through it.

$$V_{AB} = I_{AB} \cdot R.$$

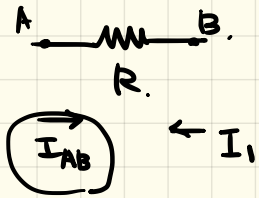


$\leftarrow I_{BA}$

$V_{BA} = I_{BA} \cdot R.$

$V_{AB} = -I_{BA} \cdot R. = -V_{BA}.$

Example!



① $V_{AB} = 10V$. $R = 1$.

$I_{AB} = ?$

$V_{AB} = I_{AB} \cdot R$. $I_{AB} = 10$.

② $V_{AB} = -10V$ $R = 1$.

$I_{AB} = ?$

$V_{AB} = I_{AB} \cdot R$. $I_{AB} = -10$.

③ $I_1 = -1A$. $V_{AB} = ?$ $= 1V$

$R = 1$.

$I_1 = I_{BA}$

$V_{BA} = I_{BA} \cdot R. = -1V.$

Note.

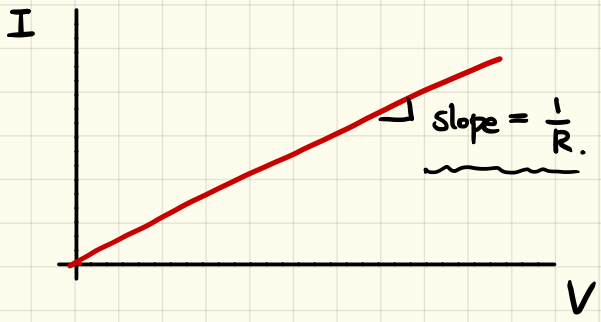
① Low R: $I = \frac{V}{R}$. $R\downarrow \rightarrow I\uparrow$.

Large R: $R\uparrow \rightarrow I\downarrow$

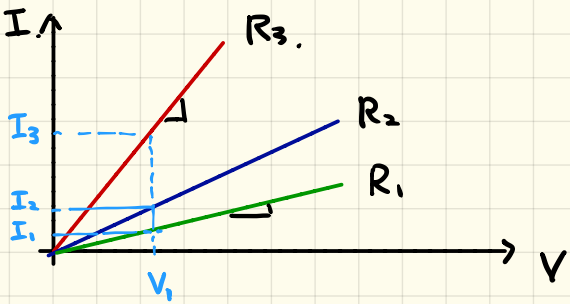
② I-V curve.

$I = \left(\frac{1}{R}\right) \cdot V$

$y = a\,x$.



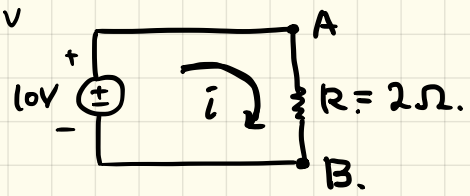
Example:



Rank resistors:

$R_1 > R_2 > R_3$.

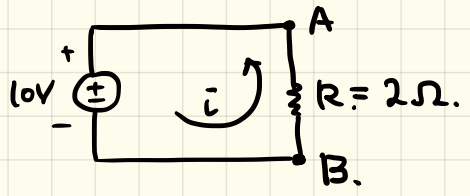
Example:



$i = I_{AB}$

$V_{AB} = i \cdot R.$

$i = 10/2 = 5A.$



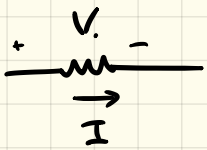
$i = -5A.$

$i = I_{BA}$

$V_{BA} = i \cdot R.$

$i = -10/2 = -5A.$

Power



$P = V \cdot I \qquad V = IR.$

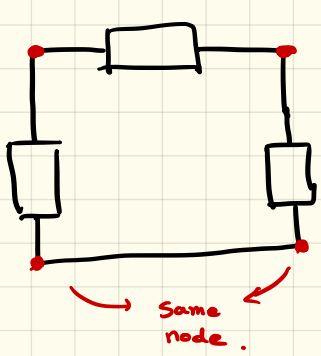
$P = IR \cdot I = I^2 R > 0 \qquad R > 0.$

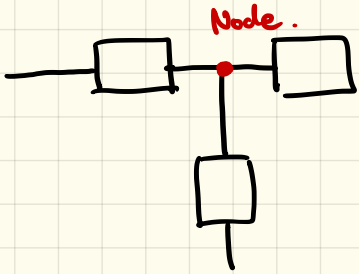
or $= V \cdot \frac{V}{R} = \frac{V^2}{R} > 0$

⇒ Resistor is a passive element : $P > 0.$

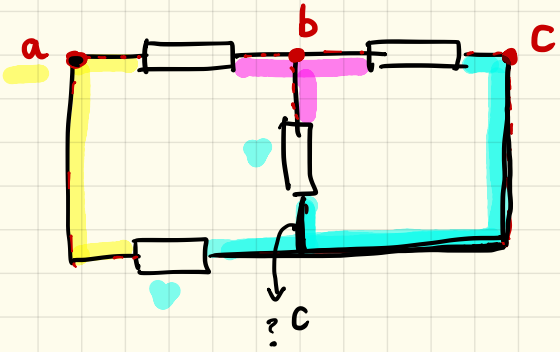
Circuit Analysis.

Node: Point at which two or more elements are connected.





note: Points connected by wires = same node.



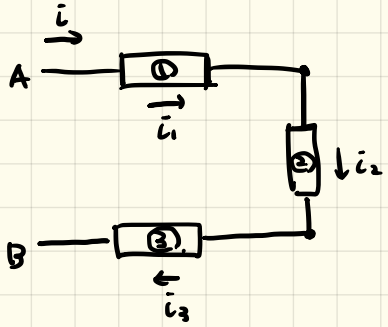
3 independent nodes.

Series connected elements:

Elements are said to be in **series** if

① They share one common node.

② The elements carry the same current.



①, ②, ③ carry same current.

$$i_1 = i_2 = i_3 = i.$$

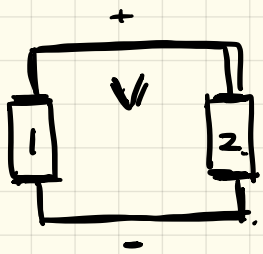
Series Resistors:

In general,

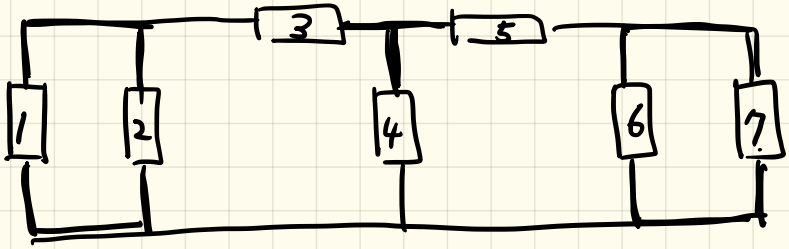
$$R_{eq} = \sum_{k=1}^{N} R_k$$

Parallel elements.

Two elements in parallel if both ends of one element are connected to both ends of another one



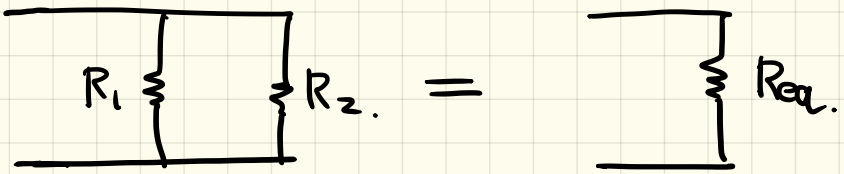
Note:



parallel connection? 6-7, 1-2.

series " ? No.

Resistors in parallel.



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

$$\Rightarrow R_{eq} = \frac{R_1 R_2}{R_1 + R_2}.$$

In general,

$$\boxed{\frac{1}{R_{eq}} = \sum_{k=1}^{N} \frac{1}{R_k}}$$

denoted by

$$R_{eq} = R_1 /\!/ R_2 /\!/ \cdots /\!/ R_N.$$