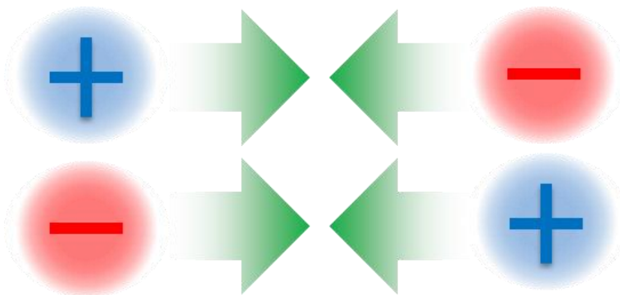
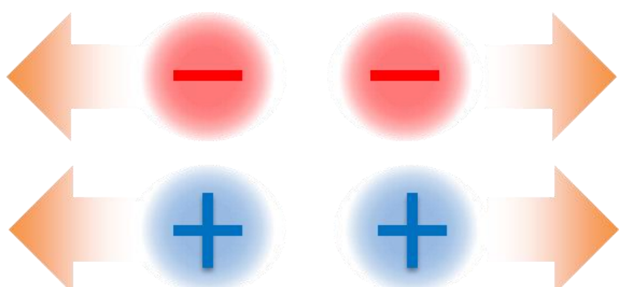
Electric charge.



Different signs: attraction



Same signs: repulsion

Charge unit in SI is “Coulomb” or just “C”

Charge conserves: it cannot be created or destroyed

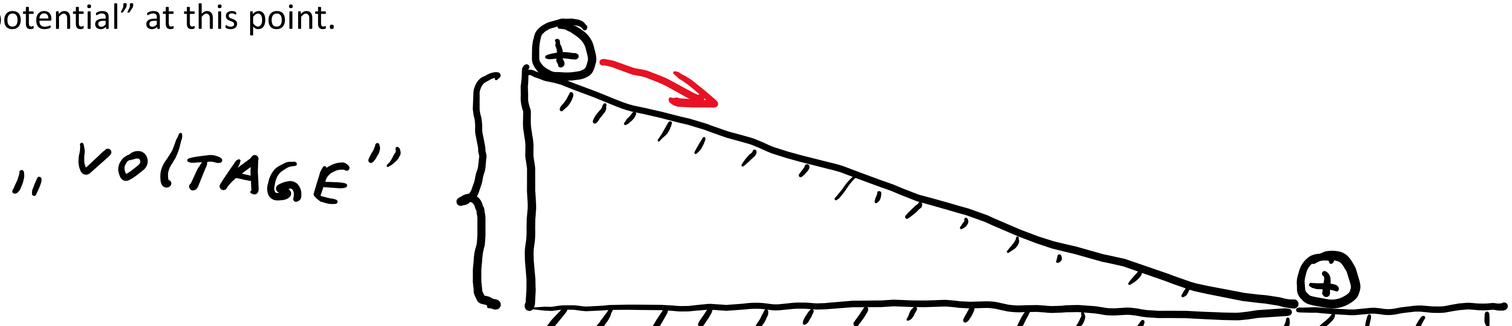
Electric potential. Voltage.

Voltage source (Battery)

Alessandro Volta (1745-1827)

If you look at an electrical battery, you will see, that one end is marked with a “+”, the other one – with “-”. This means that the “+” end has positive charge, while the other end has equal, but negative charge. Total charge of the battery is zero. So, any object, charged positively will be repelled from the “+” end and will be attracted to the “-” end. You can say that a positively charged object will have ***more*** electrostatic potential energy at the “+” end than at the “-” end. Similarly, a ball at the top of a hill has more gravitational potential energy than same ball at the foot of the hill and “wants” to roll down.

Electrostatic potential energy per unit charge in a certain point is called “electrostatic potential” or just “potential” at this point.



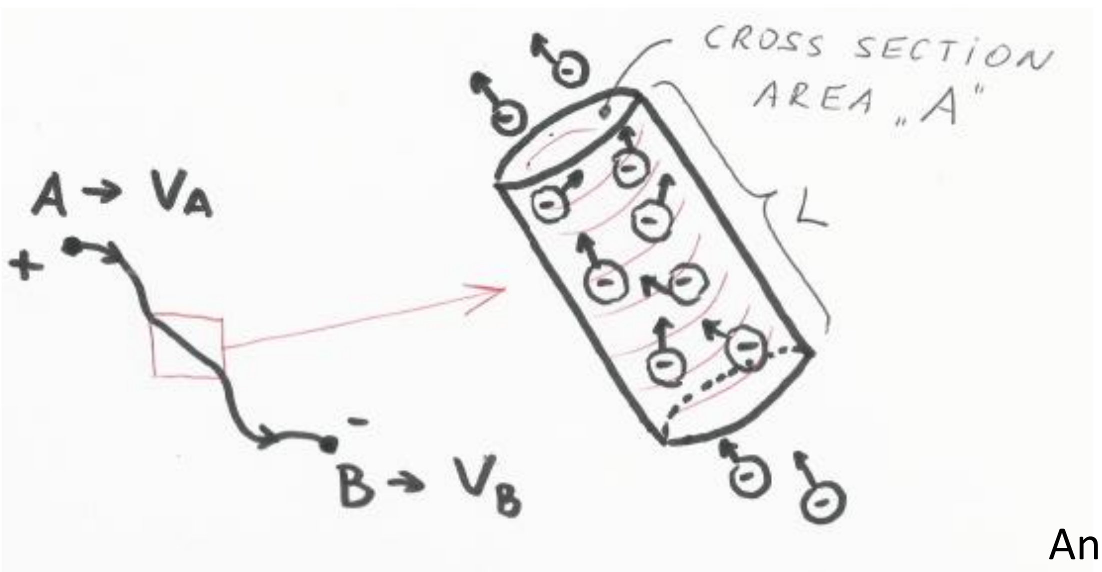
Potential difference between points A and B – “V_{AB}” is called voltage drop between A and B.

This name is given after Italian physicist Alessandro Volta (1745-1827)

V_{AB} is equal to the work done by the electric force on a unit charge when the latter is moved from point A to point B.

Electric current

Electric current is displacement of charge

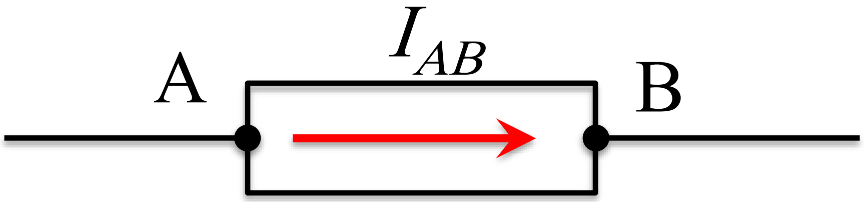


Andre-Marie Ampere (1775-1836)

Electric current magnitude ***I*** is equal to the charge passing through the cross section of the Wire per unit time.

$$[I] = A\ (Ampere) = \frac{Coulomb}{second}$$

Electric current flowing through a circuit element



$$I_{AB} = -I_{BA}$$

By definition , the direction of the current is the direction of flow of the positive charge

Electrical neutrality:

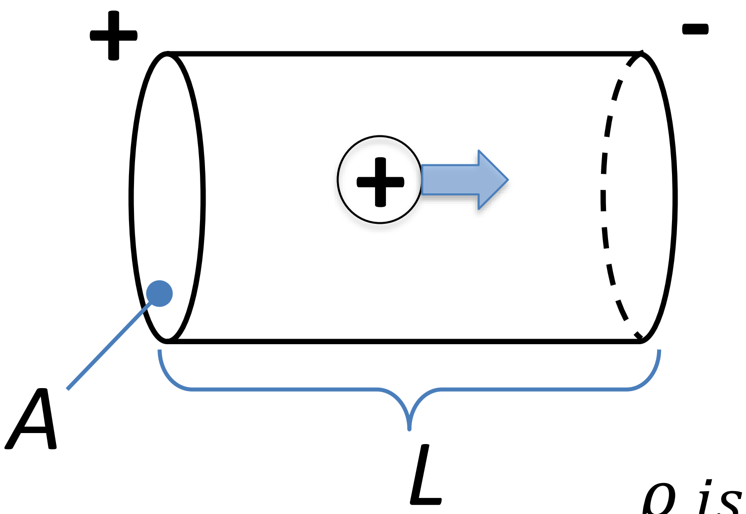
charge, entering at one end (Δq_{in}) = charge, exiting at the other end (Δq_{out})

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

Resistance. Ohm's law

Georg Simon Ohm
(1789-1854)

$$\boxed{Ohm's\ law\colon V = R \cdot I}$$



$Resistance\ of\ the\ wire\ with\ a\ length\ L$
$and\ a\ cross\ section\ area\ A$:

$$R = \frac{\varrho L}{A}, [Ohm, or\ \Omega]$$

$\varrho\ is\ the\ resistivity\ of\ the\ wire\ material$

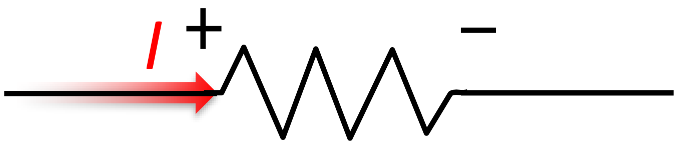
Ideal wire

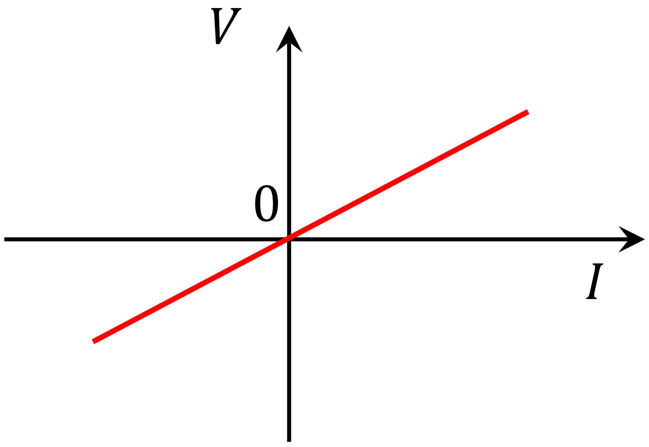
R=0

$$V_{AB} = R \cdot I_{AB} = 0 \cdot I_{AB} = 0$$

If two points are connected with an ideal wire then the voltage between these point is zero, no matter what else is connected to these points.

Resistor





Power, delivered to resistor:

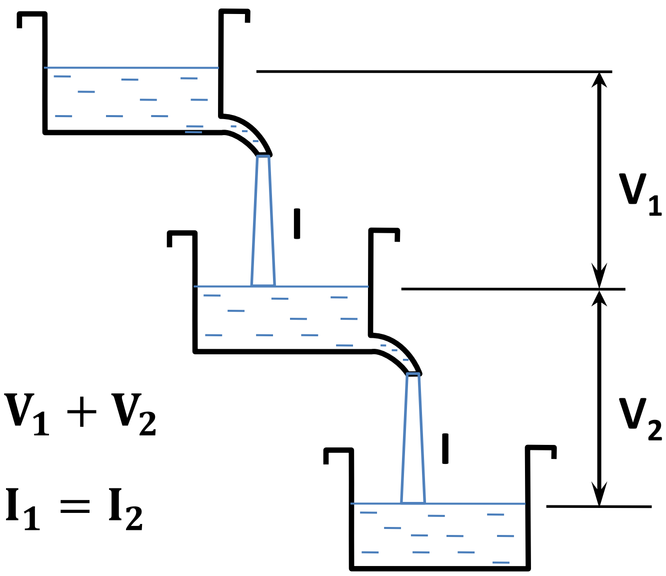
$$P = V \cdot I = I^2 \cdot R = \frac{V^2}{R} > 0$$

$$Slope = R = \frac{V}{I}$$

Resistor is a passive element. Energy, delivered to an ideal resistor is immediately converted ("dissipated")to heat. No electrical energy is stored.

Parallel and series connection of resistors

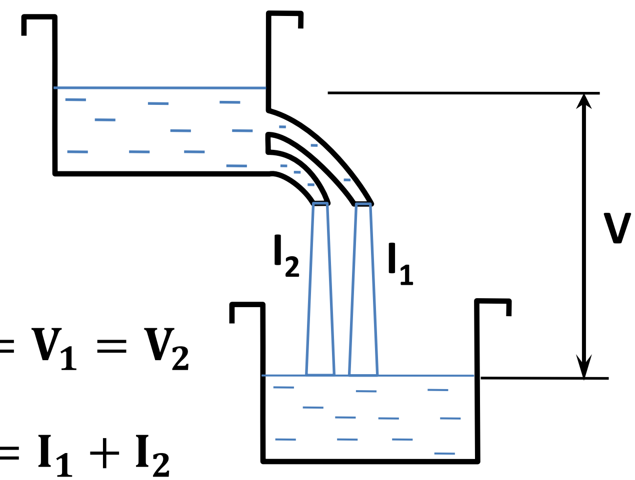
Series connection



$$\mathbf{V = V_1 + V_2}$$

$$\mathbf{I = I_1 = I_2}$$

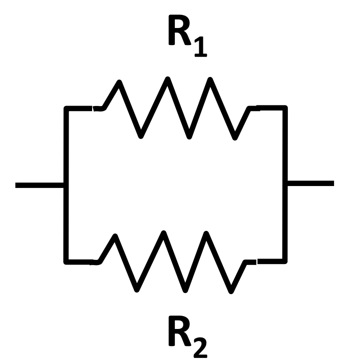
Parallel connection



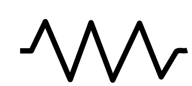
$$\mathbf{V = V_1 = V_2}$$

$$\mathbf{I = I_1 + I_2}$$

$$\mathbf{R = R_1 + R_2}$$

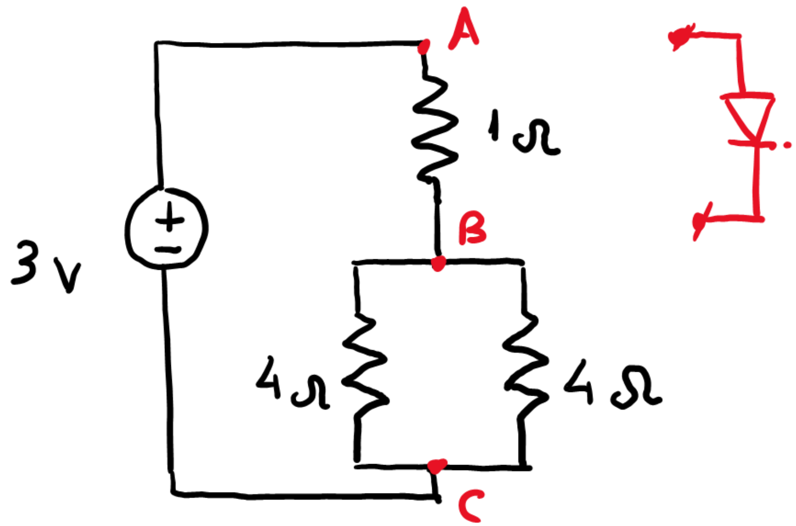


$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$



Problems:

1. The ligh emitting diode (shown in red in the Figure below) opens at 1.5V. Will it emit the light if you connect it to points A and B ? What about B and C?



Problems:

1. Two light emitting diodes (red and green)are connected as shown in Figure below. Both diodes open at the same voltage $V_{opening}$. Will they emit the light? What happens if we will change the polarity of the voltage source?