Physics 102

Lecture 9

Mon. Sept. 27, 2004

Ref: ch. 21.

- Electric Current.

  — A flow of electric charge.

Definition of electric current I:

$$I = \frac{\Delta Q}{\Delta t}$$

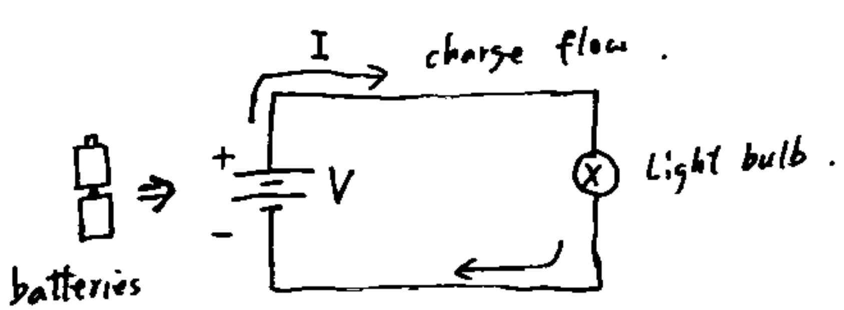
ΔQ — amount of charge flowing through a wire in Δt.

Unit: $A = C/s$ charge per unit time.

(ampere).

- What drives the flow?

  — potential difference (voltage).



- Ohm's Law. A wire (real conductor. (NOT ideal)) has a resistance R to the electric current

$$V = IR.$$

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

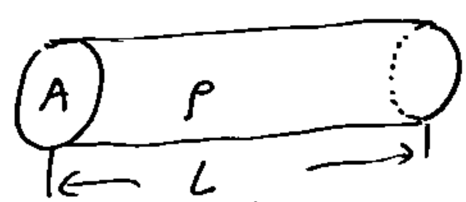
Resistance. unit: ohm (Ω).

When a device obeys ohm's law, it is said to be ohmic.

OR it is a resistor.

- Resistivity. ρ. of a material ≥ a property of the material

for a wire made of material with resistivity ρ.

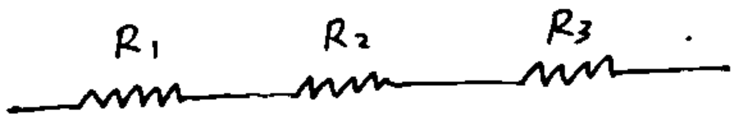


the Resistance: $R = \rho \frac{L}{A}.$

$R \propto L$

$R \propto \frac{1}{A}.$

- Resistors in Series



same as.

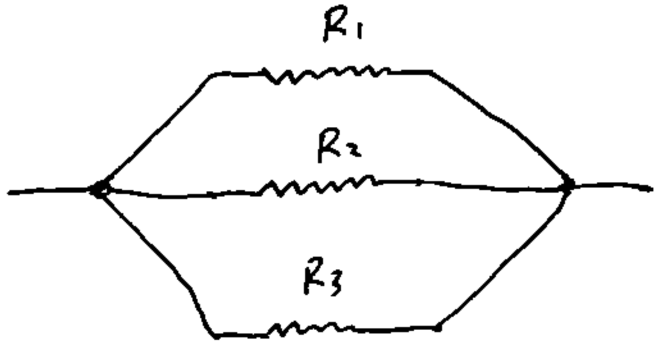
Series $R = R_1 + R_2 + R_3$

$(R > R_i)$

Easy to understand:

[Imagine. 3 wires connected in series. the lengths add $L = L_1 + L_2 + L_3$.]

- Resistors in Parallel



Same as

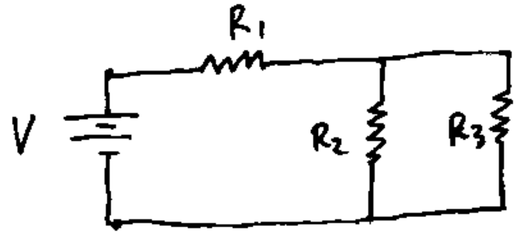
Now: for parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

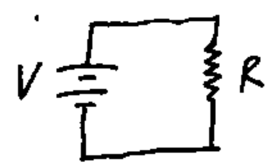
$(R < R_i.)$

[Image, the cross section area effectively becomes larger.
∴ R becomes smaller.

- e.g:



⇒ equivalent to.



$$R = R_1 + R_{23}.$$
$$= R_1 + \frac{R_2 R_3}{R_1 + R_3}.$$

$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{R_2 + R_3}{R_2 R_3}$$

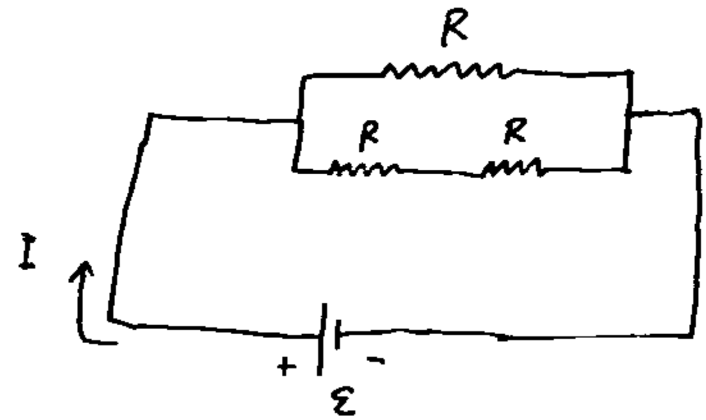
$$R_{23} = \frac{R_2 R_3}{R_2 + R_3}$$

eg. 21-7. p. 693.

given: $R = 200.0\Omega$.

$\varepsilon = 12.0\ V$.

find: $I = ?$



ε — electromotive force (emf) of the battery.

(It creates a voltage of ε volts at the terminals of the battery)

Total resistance:

$$R_T = R \,//\, (R+R).$$

$$\frac{1}{R_T} = \frac{1}{R} + \frac{1}{R+R}.$$

$$\frac{1}{R_T} = \frac{1}{R} + \frac{1}{2R} = \frac{3}{2R}$$

$$R_T = \frac{2R}{3}.$$

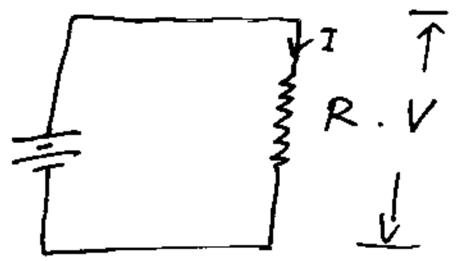
$$\therefore \quad I = \frac{V}{R_T} = \frac{V}{\frac{2R}{3}} = V \cdot \frac{3}{2R}$$

$$= 12.0\,(V) \times \frac{3}{2 \times 200\,\Omega}.$$

$$= 0.0900\,A$$

- Power in an electric circuit.

when a charge ΔQ moves across the resistor.



the change in Potential energy is:

$$\Delta U = \Delta Q \cdot V .$$

The power: $P = \frac{\Delta U}{\Delta t} = \frac{\Delta Q}{\Delta t} \cdot V = IV .$

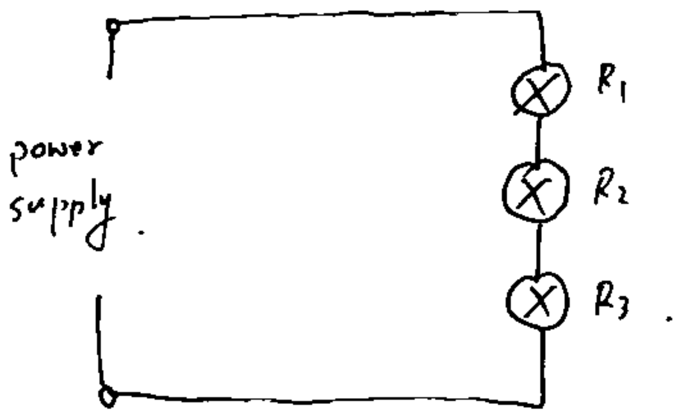
$$\therefore \boxed{P = IV .}$$

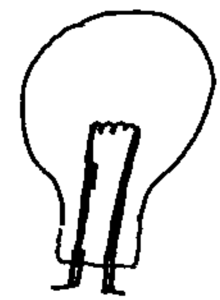
Ohm's Law: $I = \frac{V}{R}, \qquad V = IR .$

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

• Demo. ①.

Series connection of 3 light bulbs :





When one of the 3 bulbs is broken,

the other two also go off .

why ? —— the same current flows through .

If the current is "blocked" at one location,

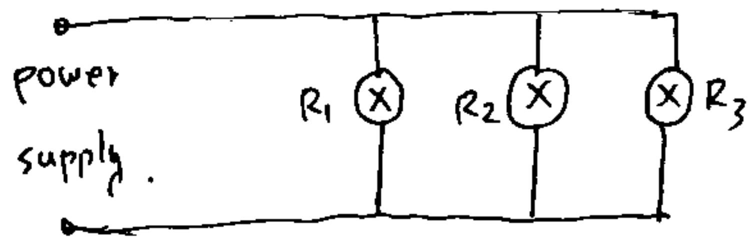
~~It [illegible] can not continue to flow~~.

It can not flow any more .

i.e. $I = 0$ everywhere .

• Demo ②.

Parallel connection of 3 light bulbs.



when a bulb is ~~bracken~~, broken

the other two are still on.

why? —— The currents are "independent".

The voltages are the same. $V_1 = V_2 = V_3$

• Demo ③.

2 light bulbs : 60 W and 25 W. {110 V.}

which one is brighter? parallel:

Series.

why?