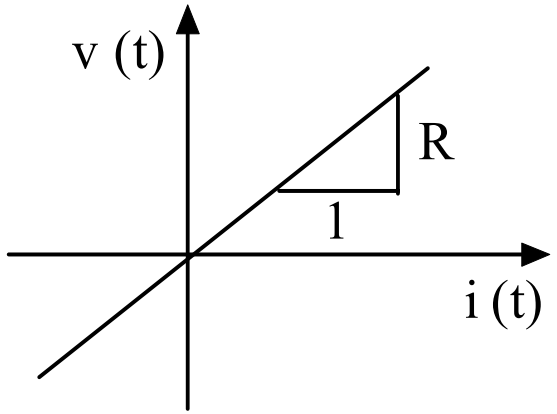
Chapter 2

Resistive Circuits

Ohm's law :

The voltage across a resistor is directly proportional to the current flowing through it.

V (t) = R i(t) **R ≥ 0**



The symbol of ohm is (Ω)

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

The instantaneous power P (t):

$$P(t) = v(t)\ i(t) = R\ i(t)\ i(t)$$

$$= R\ i^2(t) = v(t)\ \frac{v(t)}{R} = \frac{v^2(t)}{R}$$

$$\therefore\ P(t) = v(t)\ i(t) = R\ i^2(t) = \frac{v^2(t)}{R}$$

Note: Last equation says that the power at a resistor is always positive

$\Longrightarrow$ Resistors always absorb power.

The inverse of resistance is conductance

$$G = \frac{1}{R}$$

The unit of conductance is Siemens (S)

$$1\,\mathrm{S} = \frac{1\,\mathrm{A}}{1\,\mathrm{V}}$$

The current can be also expressed as

$$i(t) = G\,V(t)$$

And the instantaneous power is

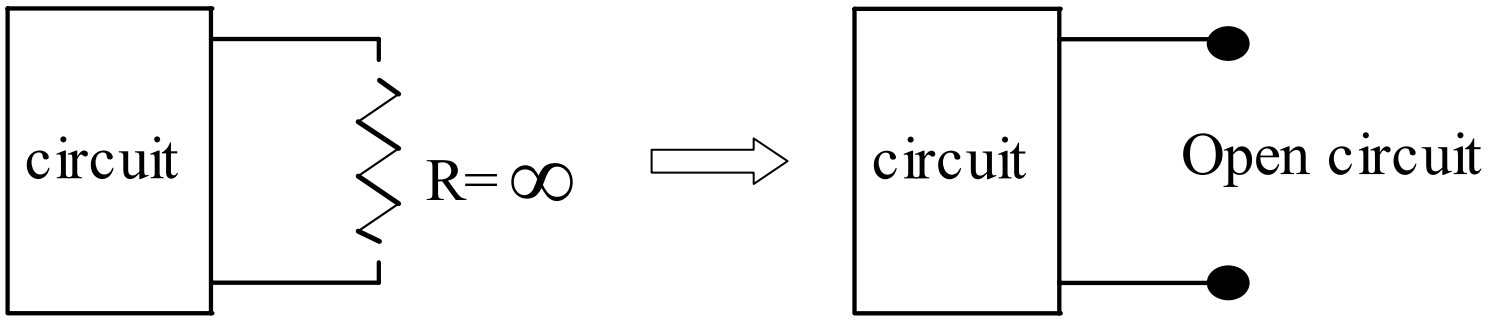
$$P(t) = v(t)i(t) = \frac{i(t)}{G}i(t) = \frac{i^2(t)}{G}$$

$$P(t) = v(t)\, i(t) = v(t)\, G\, v(t) = G\, v^2(t)$$

$$\Rightarrow = v(t)\, i(t) = \frac{i^2(t)}{G} = G\, v^2(t)$$

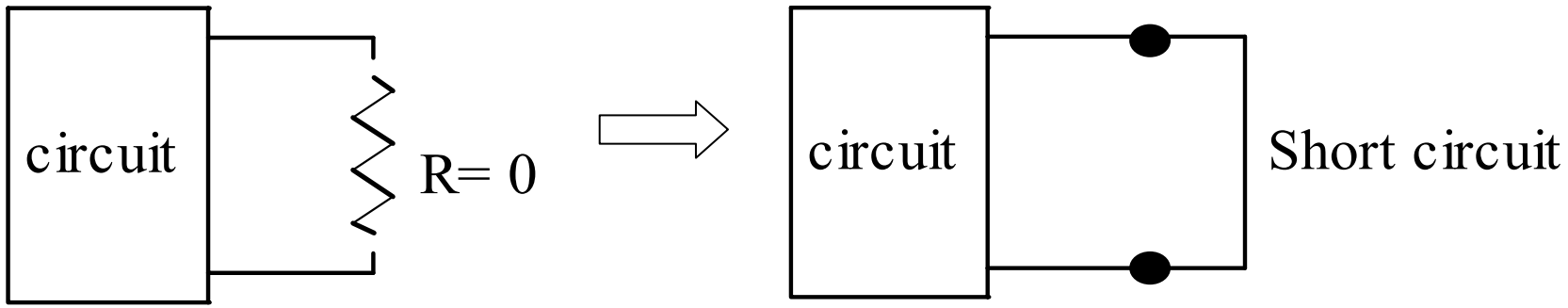
Open and short Circuits

Open circuit $(R = \infty) \Longrightarrow G = 0$



$$i(t) = \frac{v(t)}{R} = \frac{v(t)}{\infty} = 0$$

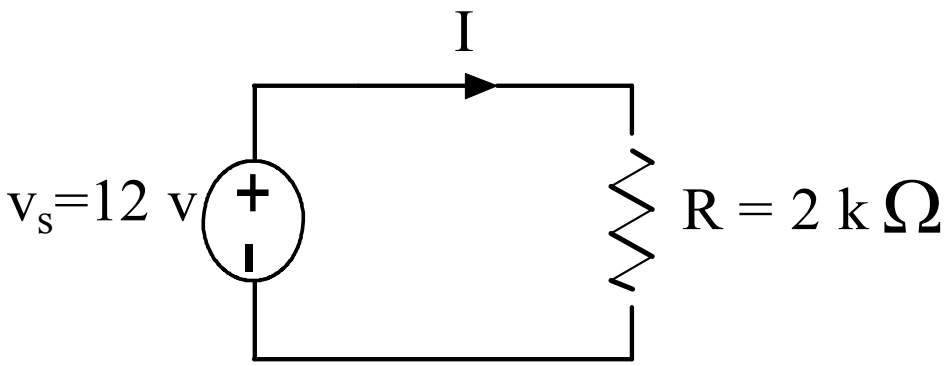
Short circuit (R = 0) $\Rightarrow$ G = ∞



$$v(t) = Ri(t) = 0 * i(t) = 0$$

Example :

Consider the circuit:



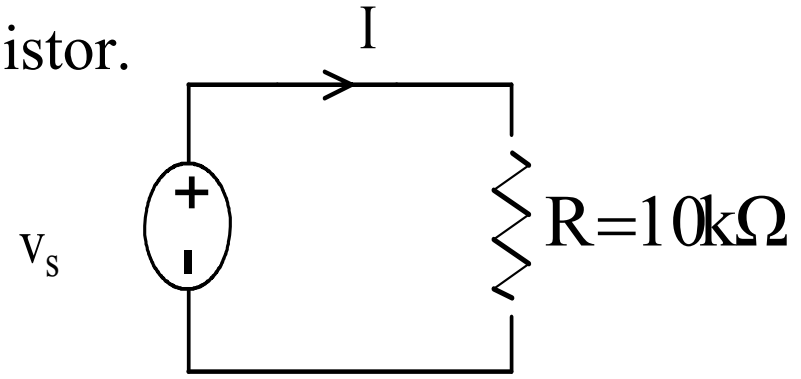
Find the current and power absorbed by the resistor

$$I = \frac{v_s}{R} = \frac{12\,v}{2\,k\Omega} = 6\,mA$$

$$P = v_R\, I = (12)(6\,m) = 72\,m\,w$$

Example:

The power absorbed by a 10 kΩ resistor in the circuit is 3.6 mW. Find voltage and current in the resistor.



$$P = V_s\, I = I^2\, R$$

$$I^2 = \frac{P}{R}$$

$$I = \sqrt{\frac{P}{R}} = \sqrt{\left(3.6*10^{-3}\right)/(10*10^{3})}$$

$$I = \sqrt{3.6*10^{-7}} = 0.6\,\text{mA}$$

$$V = I\,R = (0.6\,\text{m A})(10\,\text{k}\Omega)$$

$$V = 6\,\text{V}$$