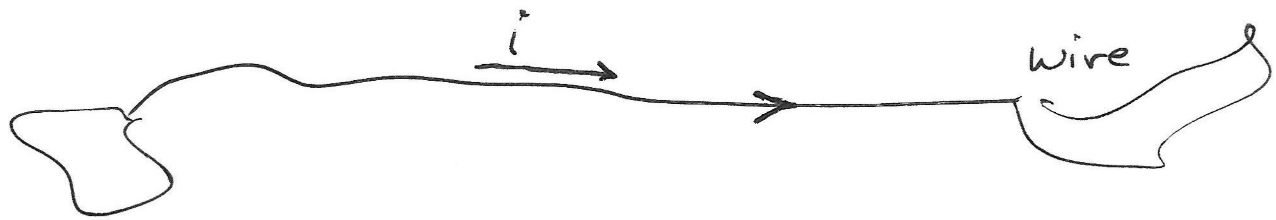
8/26

q Q charge coulombs, C

current, $i \triangleq \frac{dq}{dt}$



lower case i $\Rightarrow$ time varying current

upper case I $\Rightarrow$ constant

Resistor

units of resistance are ohms

Greek letter Ω
omega

ω is angular
rotation speed

R_3

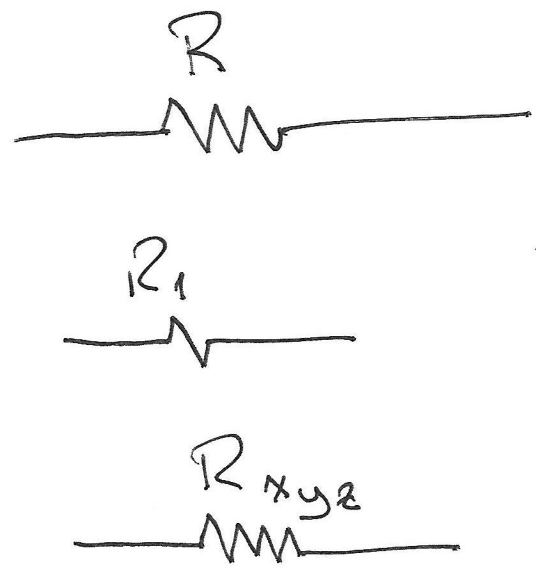
R_2
$2\ M\Omega$

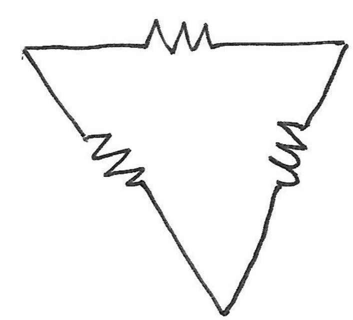
R_1
$10k\Omega$

Scientific Notation

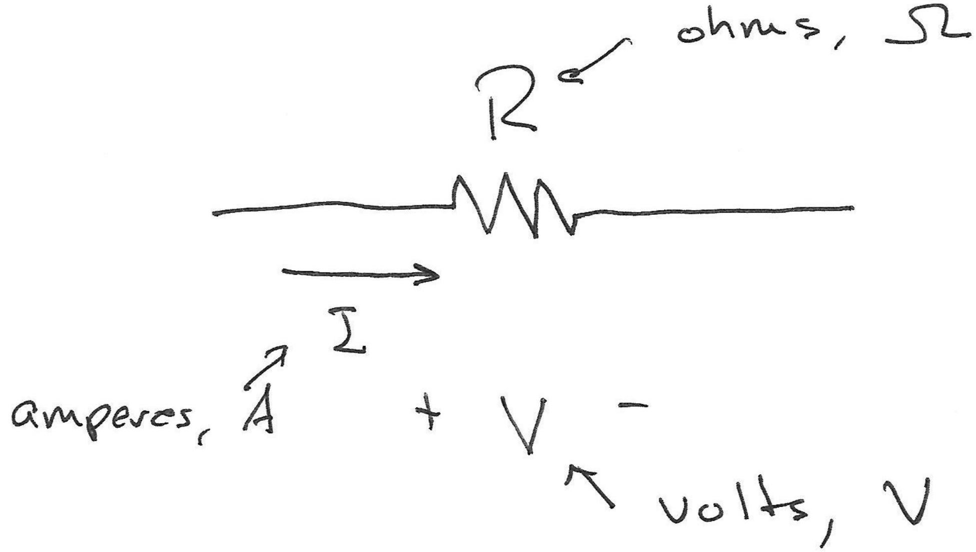
	T	10^{12}	tera
	G	10^{9}	giga
	M	10^{6}	mega
	k	10^{3}	kilo
	m	10^{-3}	milli
lower case Greek mu	μ	10^{-6}	micro
	n	10^{-9}	nano
	p	10^{-12}	pico
	f	10^{-15}	femto

Back to resistors.





If we define a current



Passive Sign Convention (PSC)

$$V = RI \qquad \text{Ohm's Law}$$

For a resistor, V and I __always__ satisfy the PSC

=> resistors __always__ absorb power.

Power:

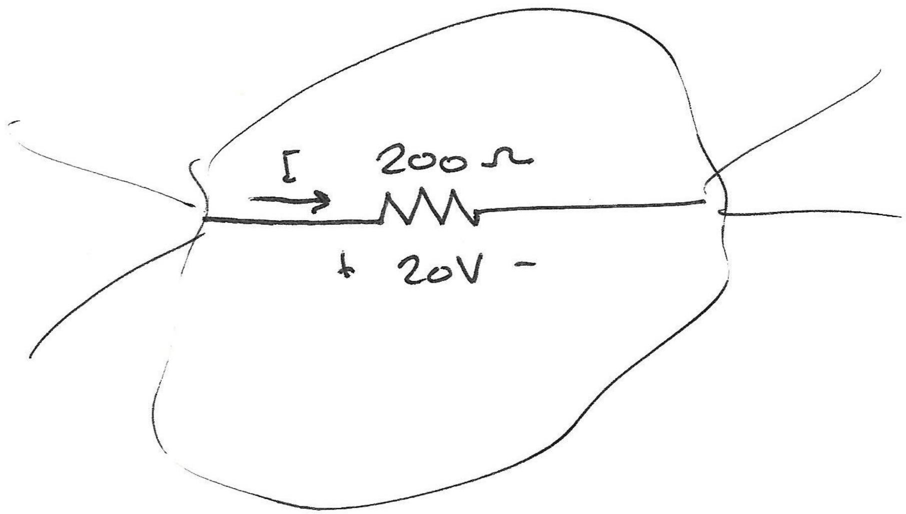
$$P = V I$$

P ← watts, W

V ← volts, V

I ← amperes, A

For a resistor, <u>if</u> V and I reference directions satisfy the PSC, then $P \geq 0$.



$I = ?$

$$V = I R$$

$V \uparrow 20$, $R \uparrow 200$

$$I = \frac{V}{R} = \frac{20}{200} = \frac{1}{10} A$$

$$= 100 mA$$

$$I = \frac{V}{R} = \frac{1}{R} V$$

conductance

G ~~mhos~~

siemens, S

Capacitor

farads, F

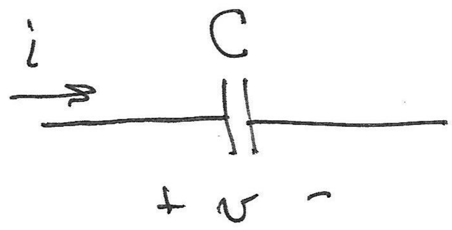
C_1

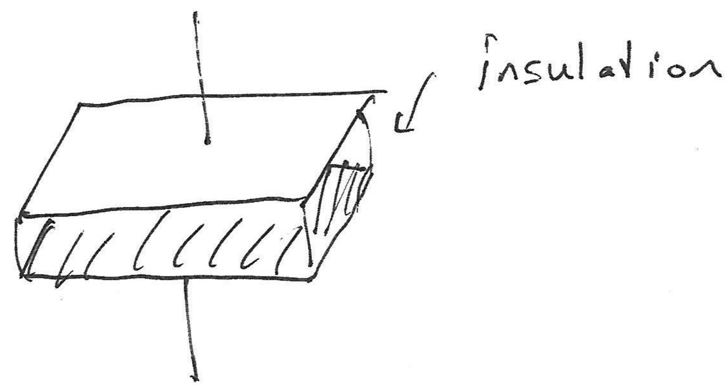
$50 \mu F$

C_2

C_3

$20 pF$

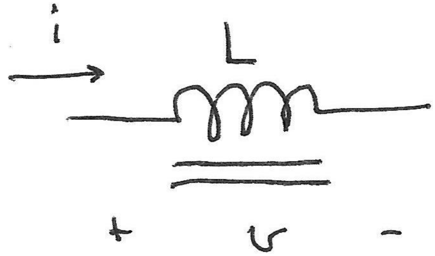




If we define a current i and a voltage v, that satisfy the PSC, then

$$i = C \frac{dv}{dt}$$

Inductor



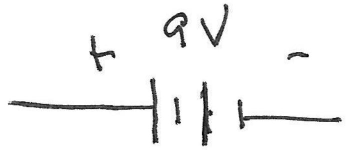
If v and i satisfy the PSC,

then

$$v = L \frac{di}{dt}$$

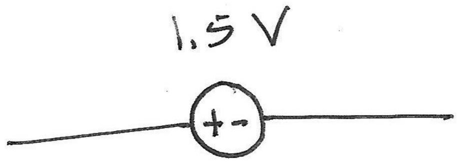
(v: volts; L: henry, H; i: amperes; t: seconds)

Sources:

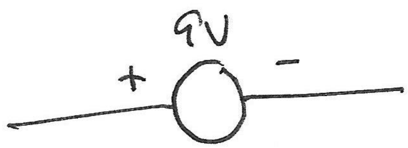


battery symbol

voltage source



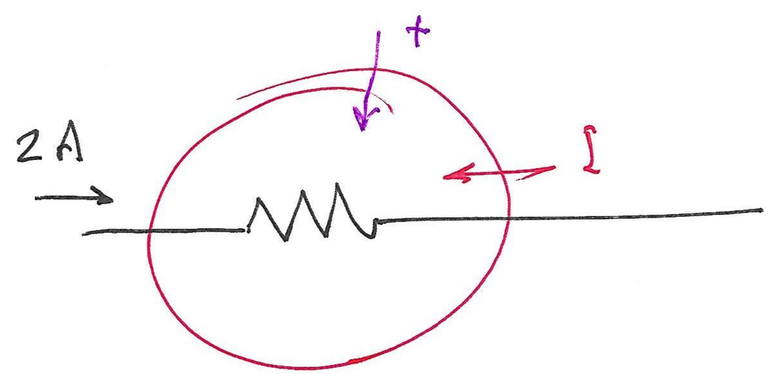
standard flashlight battery, or clock battery



Most of the time, sources <u>do not</u> satisfy the PSC because they deliver power.

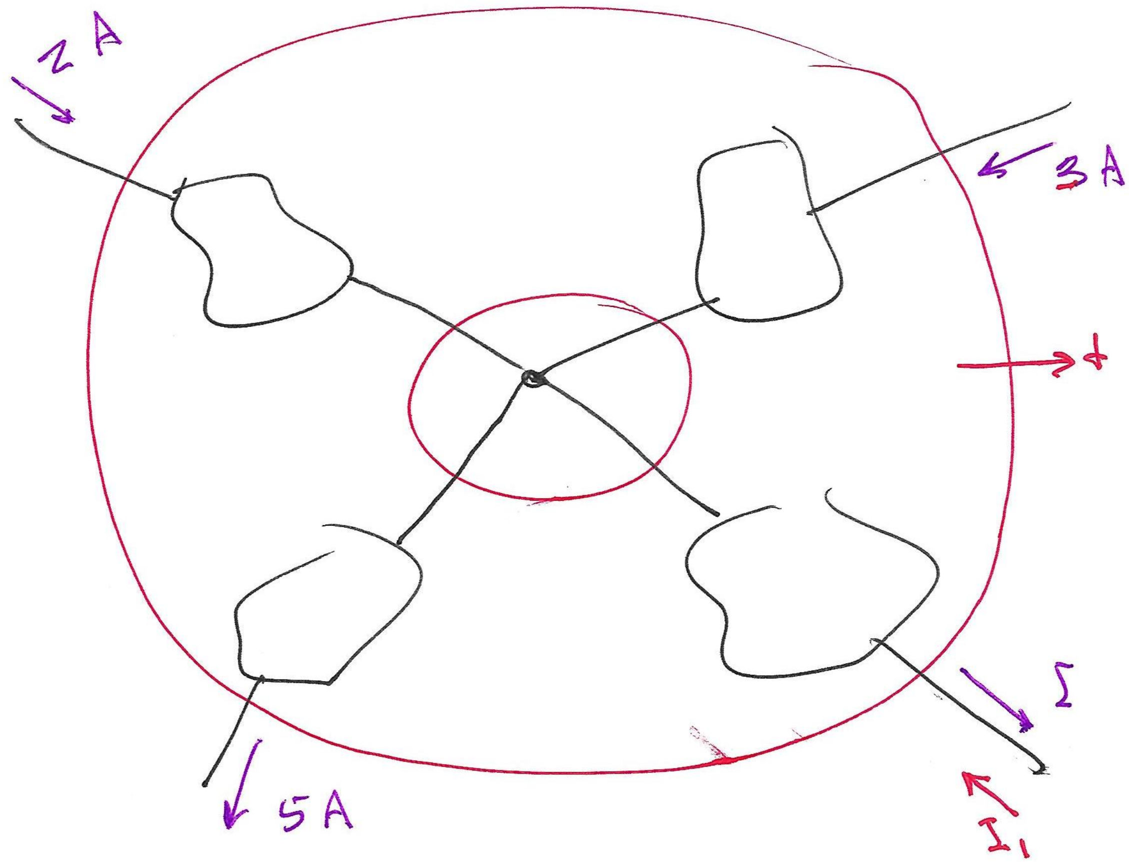
Kirchhoff's Laws:

1. The algebraic sum of all currents crossing any closed boundary is zero.



Kirchhoff's Current Law:
(KCL)

$$2A + I = 0$$
$$\Rightarrow I = -2A$$

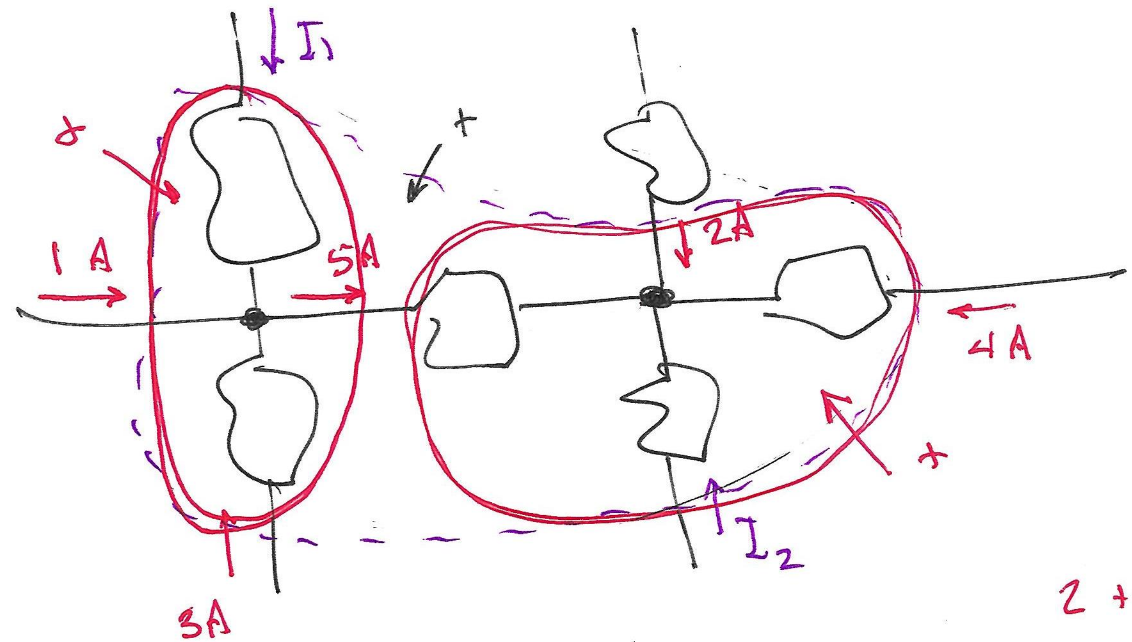


KCL: $-3 - 2 + 5 + I = 0$

$\Rightarrow I = 0$

$I_1 + 1 + 3 - 5 = 0$

$I_1 = 1A$



$2 + 4 + I_2 + 5 =$

$I_2 = -11\ A$

$I_1 = ?$

$I_2 = ?$

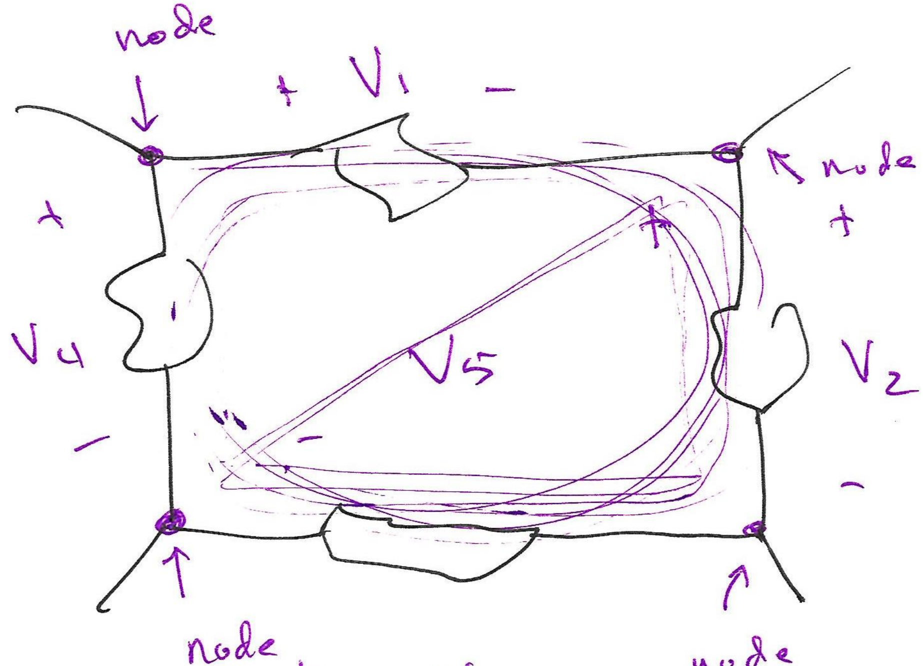
$I_1 + 1 + 3 + I_2 + 4 + 2 = 0$

$\uparrow \qquad\qquad \uparrow$

$1 \qquad\qquad -11 \qquad = 0$

Kirchhoff's Voltage Law (KVL):

The algebraic sum of all voltages encountered around any closed path is zero.



If $V_1 = 10V$

$V_4 = 12V$

then $V_5 = ?$

$+V_1 + V_5 - V_4 = 0$

$10 + V_5 - 12 = 0$

$V_5 = 2V$

If $V_2 = 16V$,

then $V_3 = ?$

$$-V_5 + V_2 - V_3 = 0$$

$$-2 + 16 - V_3 = 0 \Rightarrow V_3 = 14V$$

$$-V_4 + V_1 + V_2 - V_3 = 0$$

$$-12 + 10 + 16 - V_3 = 0 \Rightarrow V_3 = 14V$$