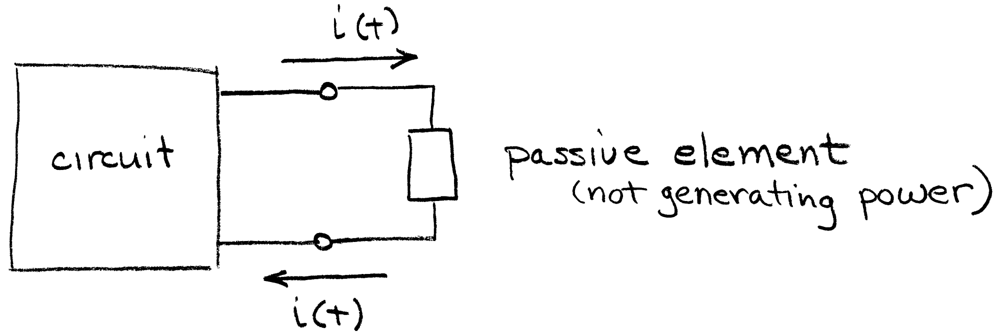
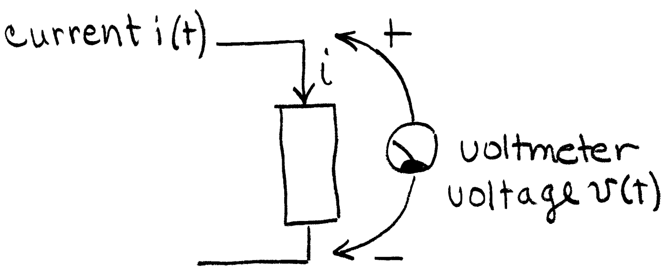
The passive sign convention



The electrons flow through the device being neither created or destroyed.

However, depending upon the device the electrons can lose energy. This is measured by the voltage across the device.

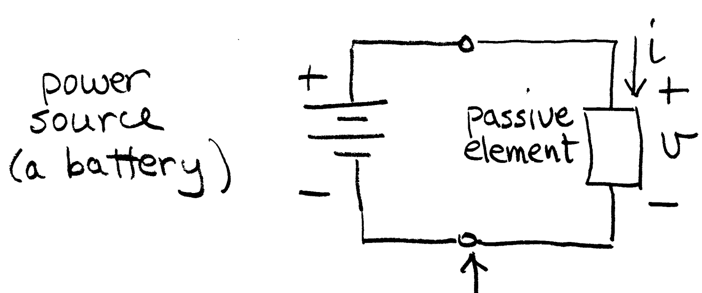


These are reference signs and directions.

When electrons lose energy it is typically manifested as heat. Other possibilities are light, sound and electromagnetic radiation.

The power lost is $p = v(t)\, i(t) > 0$

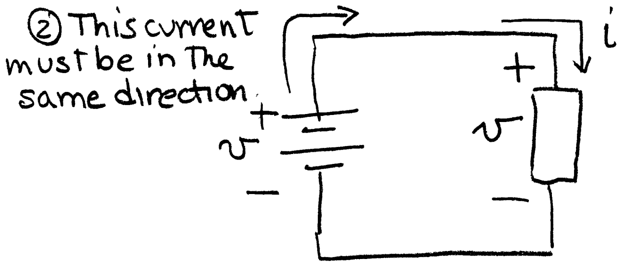
If this device were transferring energy to the electrons this would be indicated by a change in the sign of the voltage, i.e. $p < 0$ for power generation



passive sign convention gives $p = vi > 0$ for power loss

connects where elements come together are called nodes

A battery is an active element (an energy source)



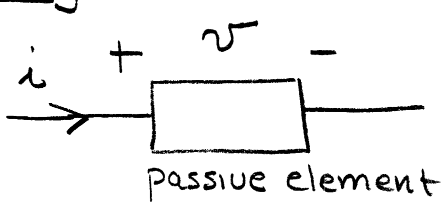
① Assume passive element is converting electrical energy to something else.

③ by passive sign convention the power loss by the passive element is $p = vi > 0$

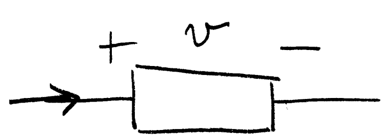
④ by passive sign convention the power supplied by the battery is $p = vi < 0$

Note that the voltage across the battery and the passive element are the same.

<u>Passive sign convention</u>



The are the directions and polarities we <u>assume</u> for positive. We can get positive and negative quantities



A current of −5 amperes means the current is actually going in the opposite direction,

GROUND

A o   B o   C o

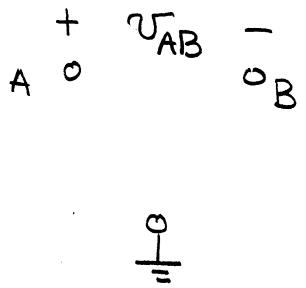
symbol for electrical ground
common voltage reference

The notation $v_A(t)$, $v_B(t)$, $v_C(t)$ means the voltage at that node with respect to ground, assumed to be zero.

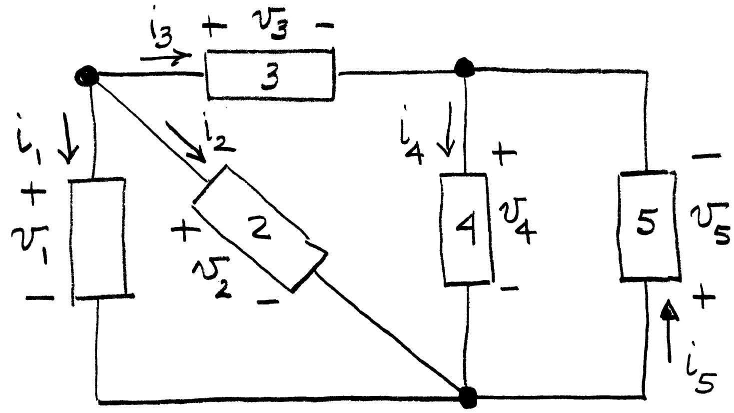
Voltage <u>ALWAYS</u> is measured between two points.

I might also be interested in the voltage

$v_{AB}(t)$ This is the voltage between two nodes. Polarity should be indicated on circuit diagram.



Example 1-3



In this circuit the sign conventions are given on the drawing. If they are not given you should assign them!

The above labeling follows the passive sign convention. The following circuit variables are measured. Complete the missing variables. State whether the device is absorbing or supplying power.

	Device 1	Device 2	Device 3	Device 4	Device 5
v	+100 V		+25V	+75V	−75 V
i		+5mA	+5mA		+5mA
p	−1 W	+0.5W		0.75W	

Use $p = vi$

$i_1 = \frac{P_1}{v_1} = \frac{-1}{100} = -.01$ Amp $\quad P_1 < 0 \Rightarrow$ supplying power

$v_2 = \frac{P_2}{i_2} = \frac{0.5}{0.005} = 100V \quad p > 0 \Rightarrow$ absorbing power

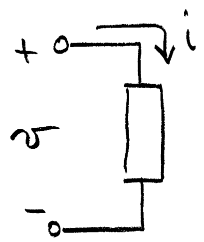
$P_3 = v_3 i_3 = (25)(.005) = 0.125 \quad p > 0 \Rightarrow$ absorbing power

$i_4 = \frac{P_4}{v_4} = \frac{0.75}{(75)} = 0.01 \quad p > 0 \Rightarrow$ absorbing power

$P_5 = v_5 i_5 = (-75)(.005) = -0.375 \quad p < 0 \Rightarrow$ supplying power

2-1 Element Constraints

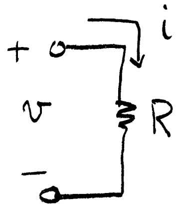
A two terminal device is described by its v-i characteristics.

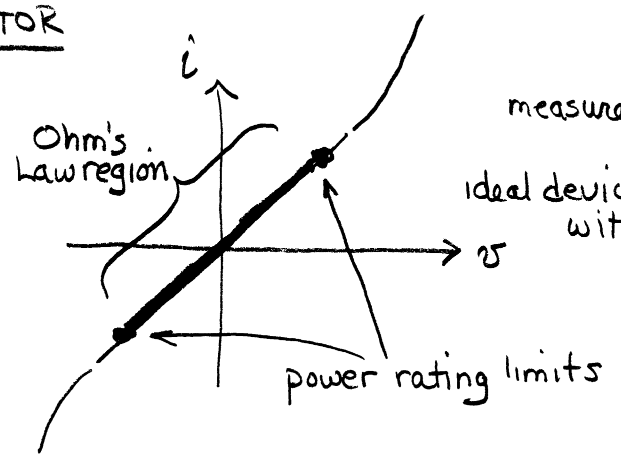


device - the "real" electrical device

element - our model

LINEAR RESISTOR





measured v-i characteristic

ideal device is linear within its operating range

outside the operating range the v-i relationship might be non-linear

characteristics are symmetric about origin

For the sign convention given (passive sign convention)

$i = \left(\frac{1}{R}\right) v$ where $\frac{1}{R}$ is the slope

Normally we write this as

$v = iR$

or $i = Gv$

$R = \frac{1}{G}$, where R is resistance (ohms, Ω) and G is conductance (Siemens, S)

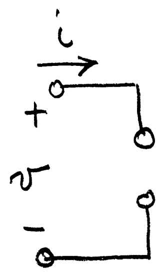
and call this Ohm's Law.

Since $p = vi > 0$ a resistor always absorbs power.

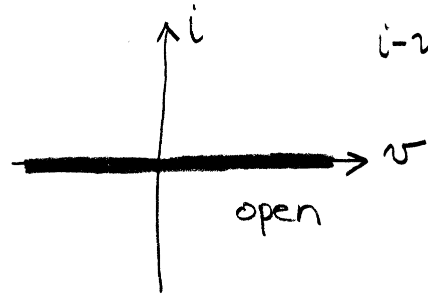
Note: $p = vi = (iR)i = i^2R$
and $p = vi = v\left(\frac{v}{R}\right) = \frac{v^2}{R}$

} we usually use R, rarely G

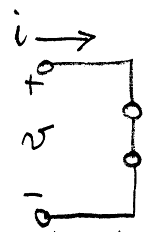
Open and short circuits, switches



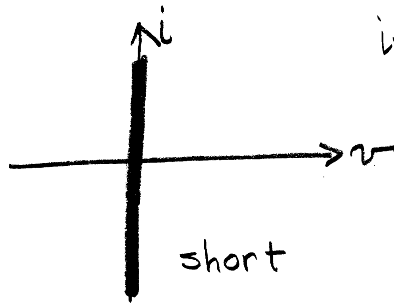
open



i-v characteristic

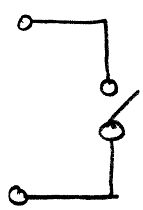


short

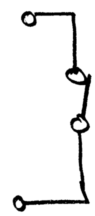


i-v characteristic

ideal switch



open position
(OFF)

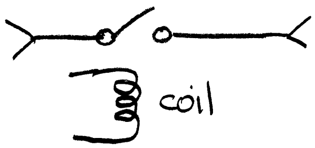


closed position
(ON)

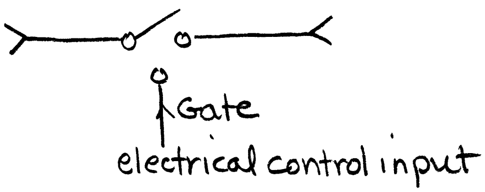
Actual switches have limitations

- maximum current
- maximum voltage
- mechanical actuation (pressure, force)
- operating cycles

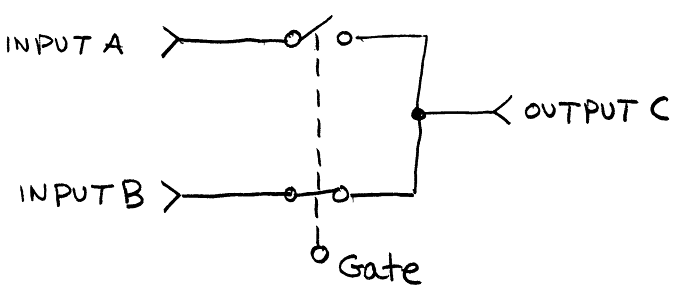
controlled switches
computer controlled switches



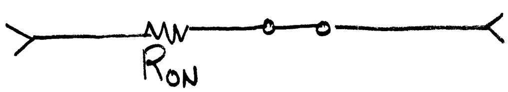
RELAY



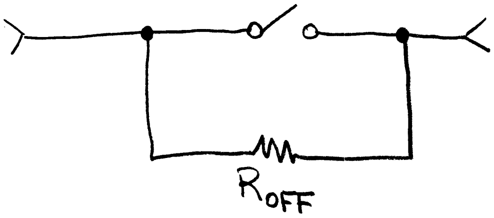
ANALOG SWITCH



MULTIPLEXER (MUX)



switch model with finite ON resistance



switch model with finite OFF resistance