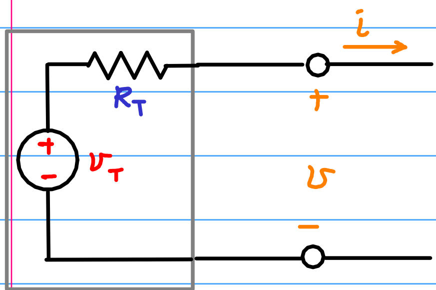
Voltage & Current Sources (H.1)

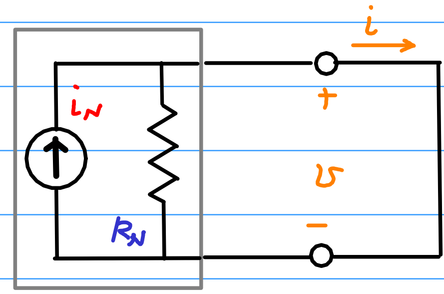
20170407

Source Side Equation R_T

max v ← $R_L = \infty$

max i ← $R_L = 0$

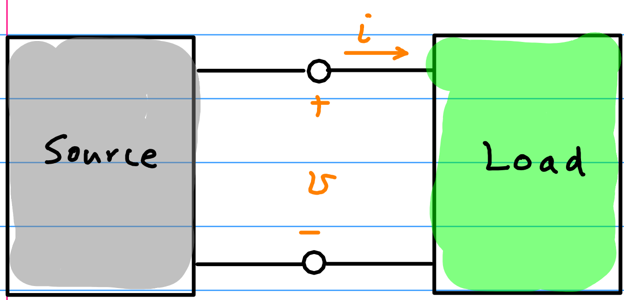


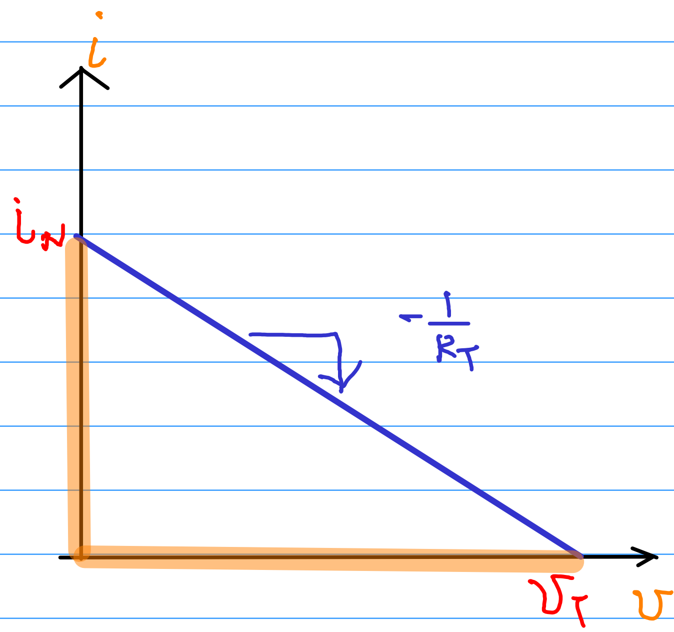


$i < i_N$

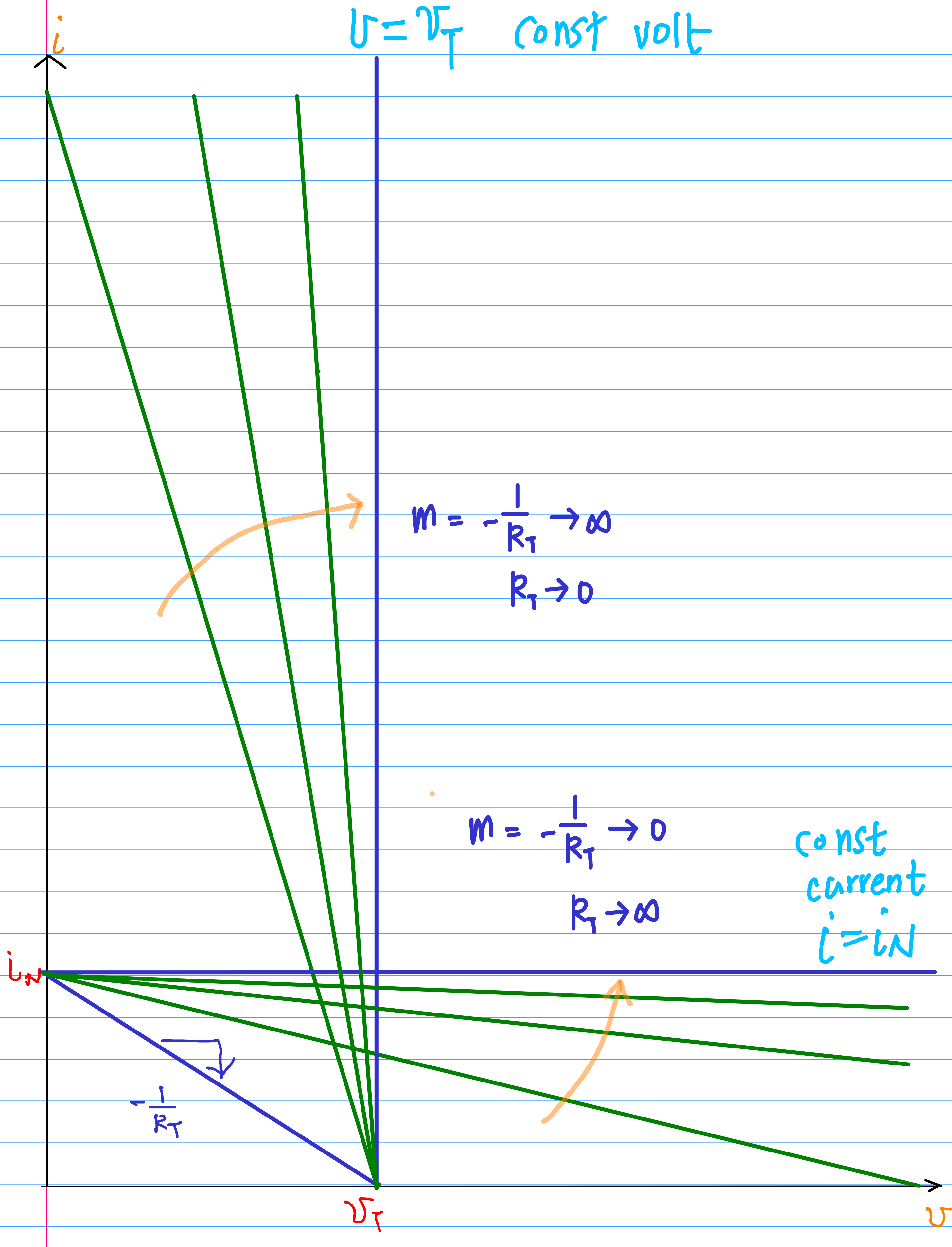
$v < v_T$

$0 < R_L < \infty$



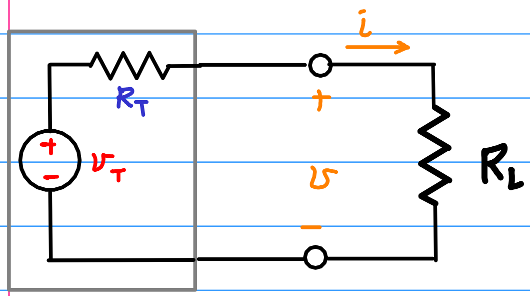


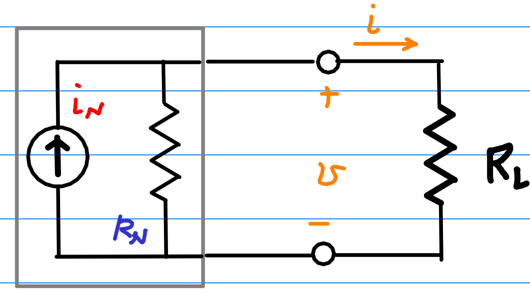
$$i = \frac{1}{R_T}(v_T - v)$$

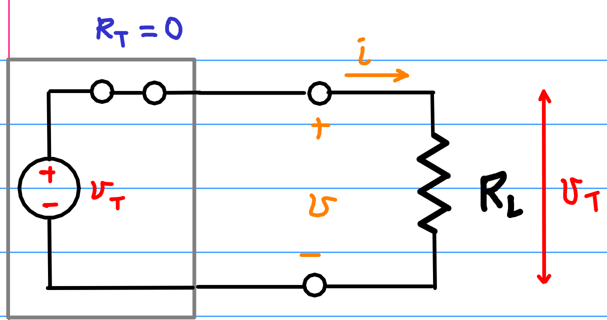


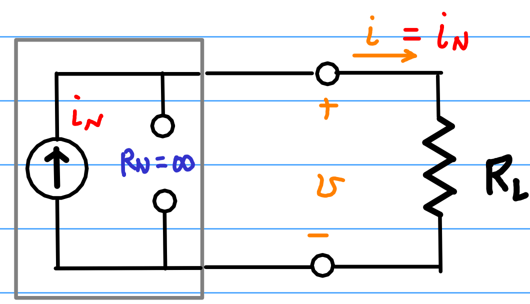
$v = v_T$ const volt
i
$m = -\frac{1}{R_T} \to \infty$
$R_T \to 0$
$m = -\frac{1}{R_T} \to 0$
$R_T \to \infty$
const current
$i = i_N$
i_N
$-\frac{1}{R_T}$
v_T
v

R_N & R_T for sources









$R_T = 0 \longrightarrow v = v_T$

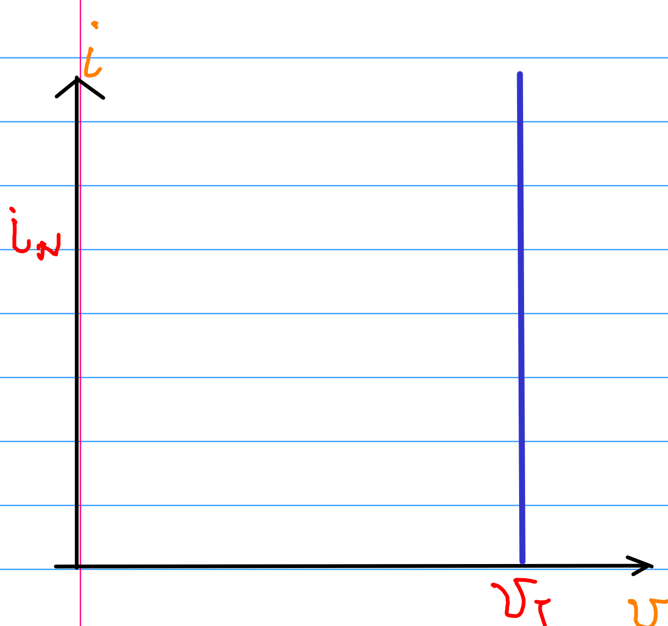
regardless of R_L

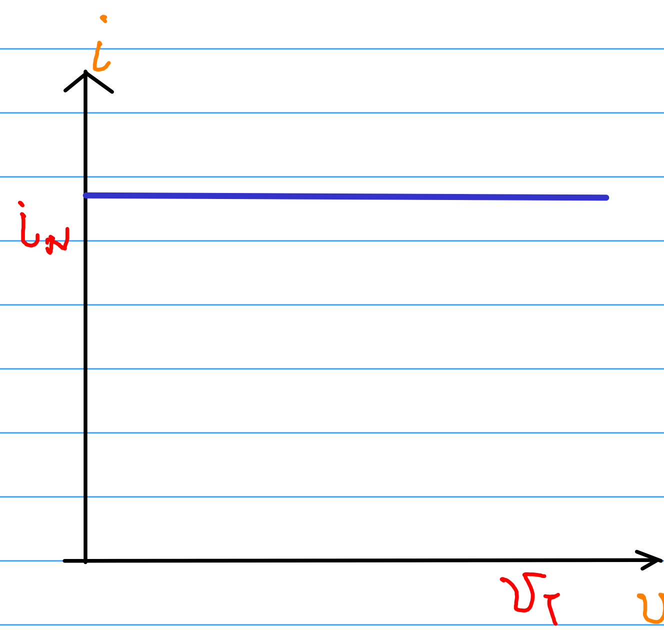
* Ideal Voltage Source

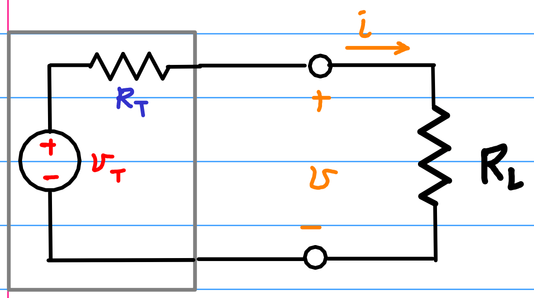
$R_N = \infty \longrightarrow i = i_T$

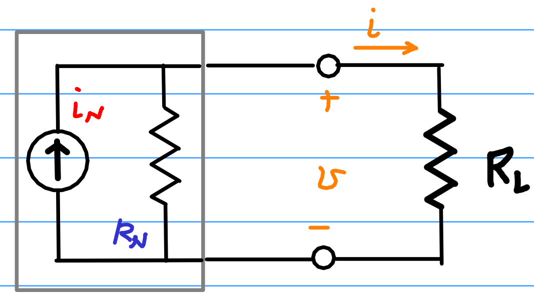
regardless of R_L

* Ideal Current Source









$$v = \frac{R_L}{R_T + R_L} v_T$$

$$i = \frac{R_N}{R_N + R_L} i_N$$

$R_T \ll R_L$

$R_N \gg R_L$

$$v \approx \frac{R_L}{R_L} v_T = v_T$$

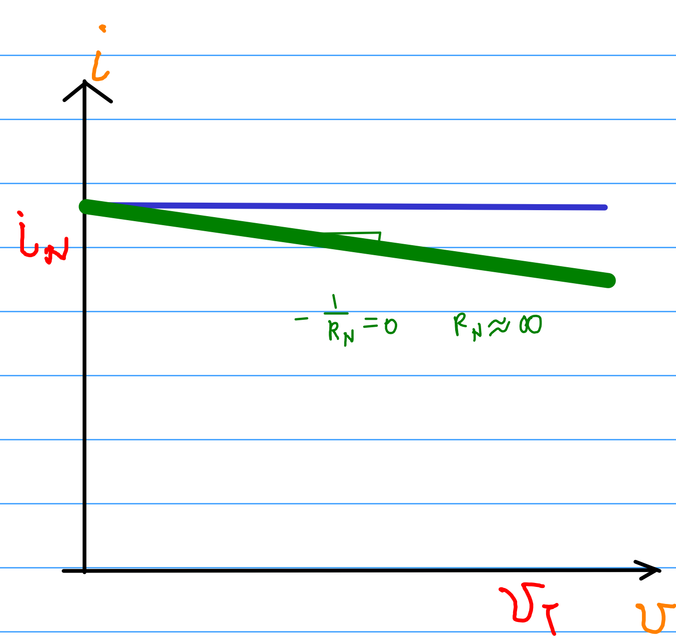
$$i = \frac{R_N}{R_N} i_N = i_N$$

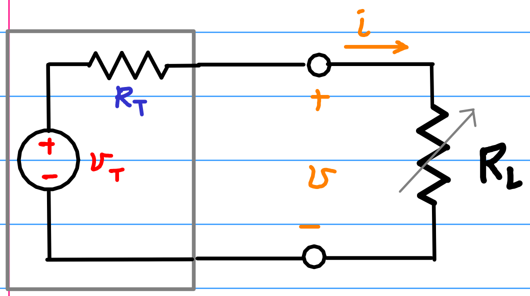
$$v = \frac{1}{0.01 + 1} v_T$$

$$= \frac{1}{1.01} v_T \approx 0.99 v_T$$

$$v = \frac{100}{100 + 1} v_T$$

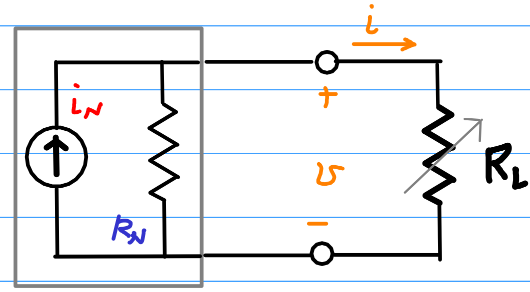
$$= \frac{100}{101} v_T \approx 0.99 v_T$$





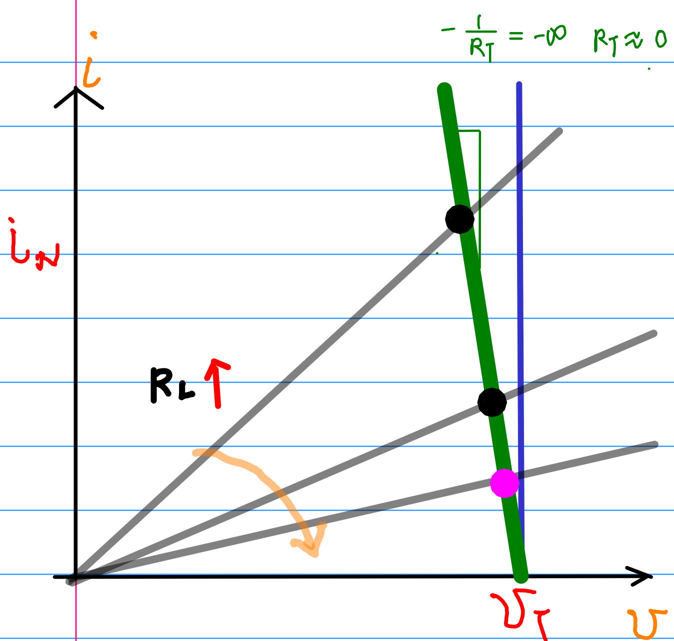
$$v = \frac{R_L}{R_T + R_L} v_T = \frac{1}{\frac{R_T}{R_L} + 1} v_T$$

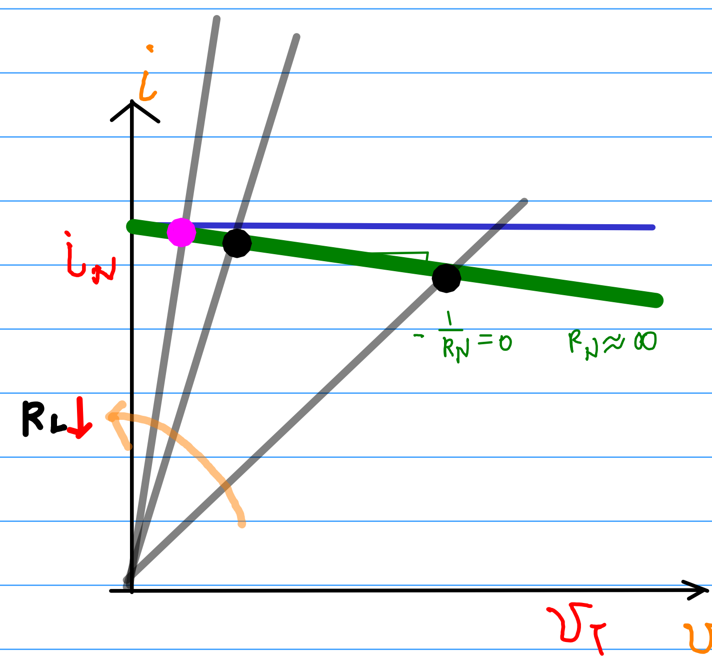
$R_T \ll R_L$

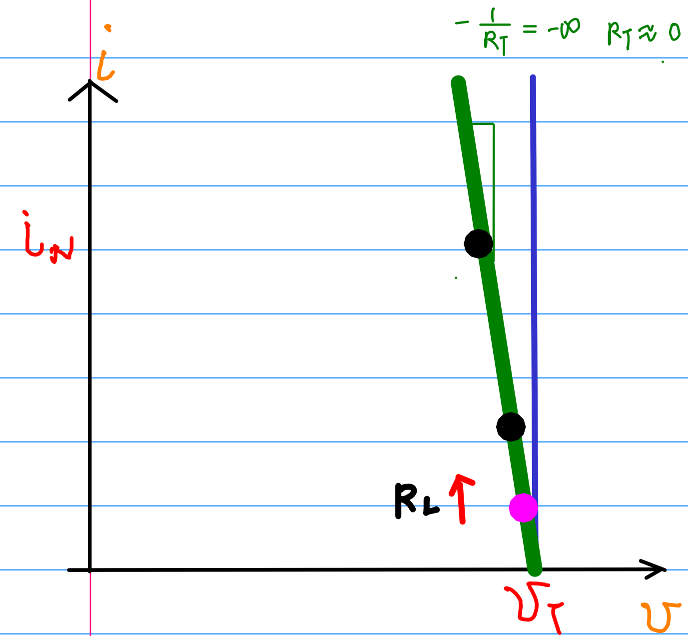


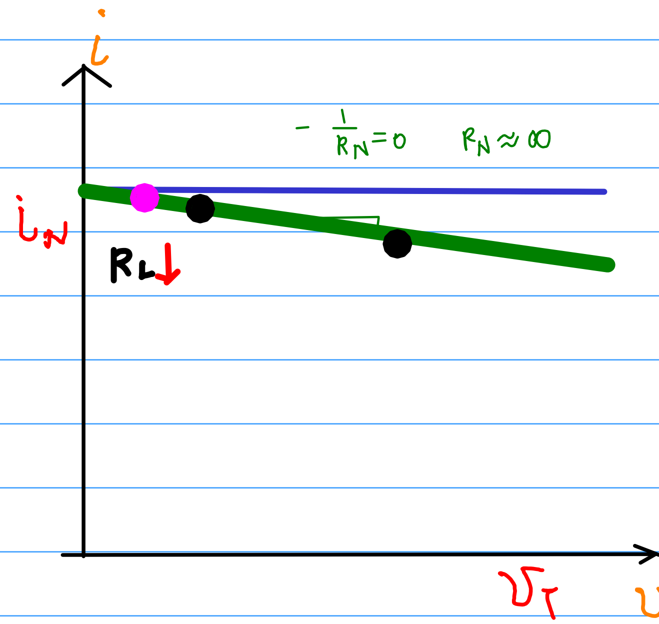
$$i = \frac{R_N}{R_N + R_L} i_N = \frac{1}{1 + \frac{R_L}{R_N}} i_N$$

$R_N \gg R_L$







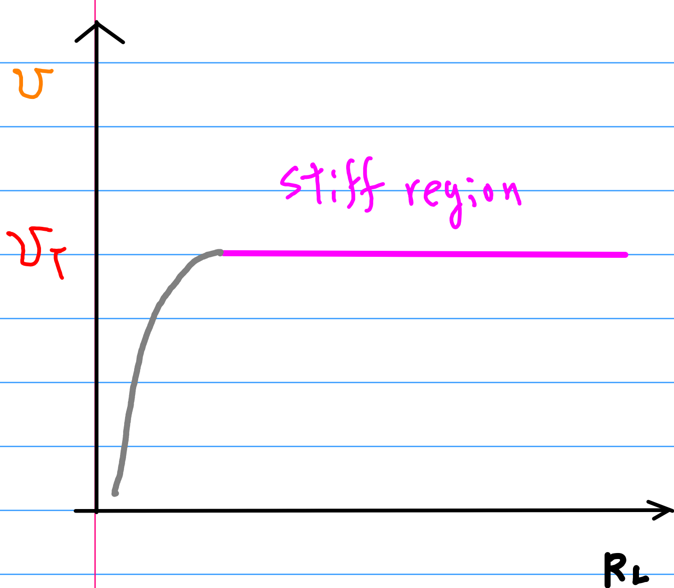


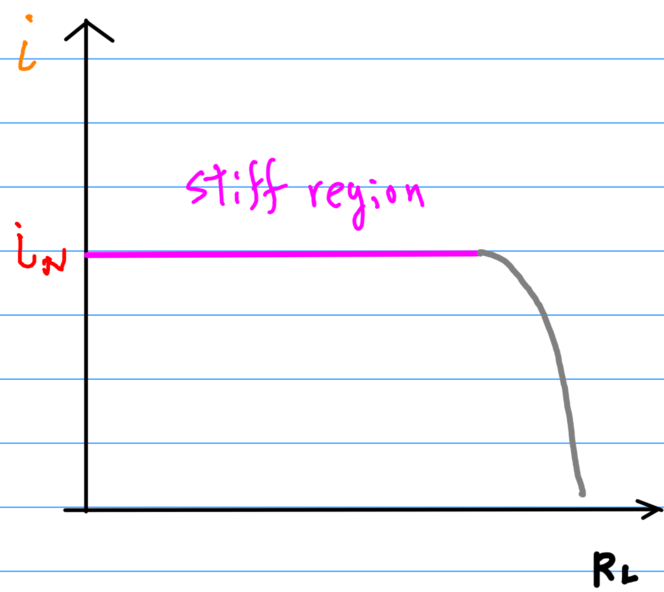
$$v = \frac{1}{\frac{R_T}{R_L} + 1} v_T$$

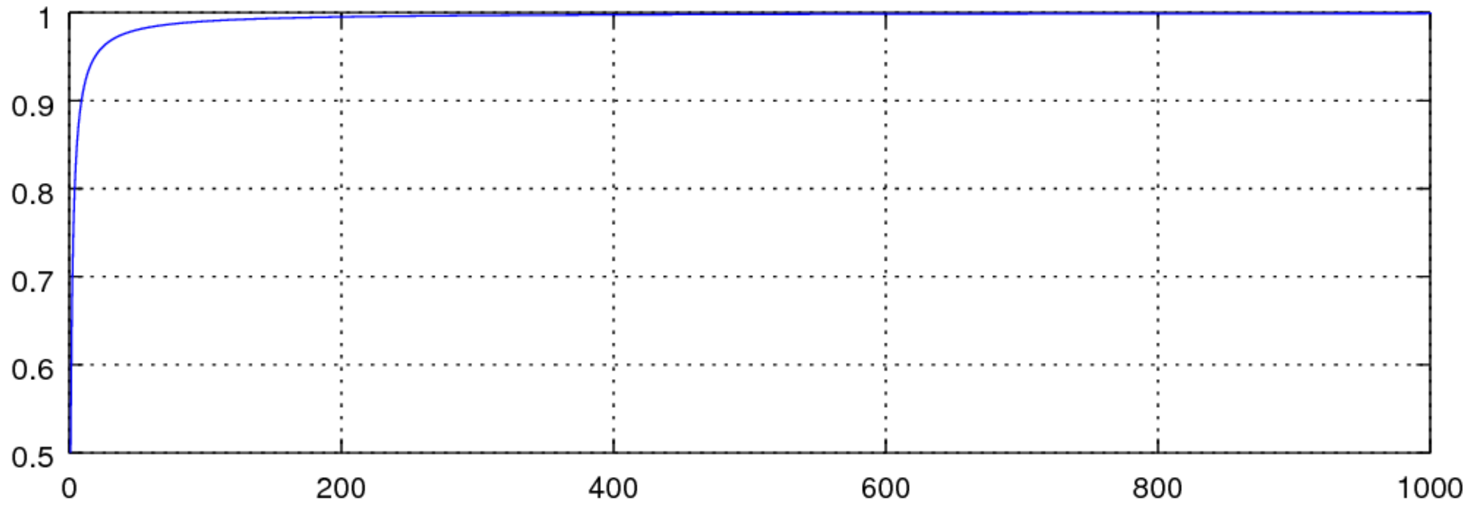
$R_T \ll R_L$

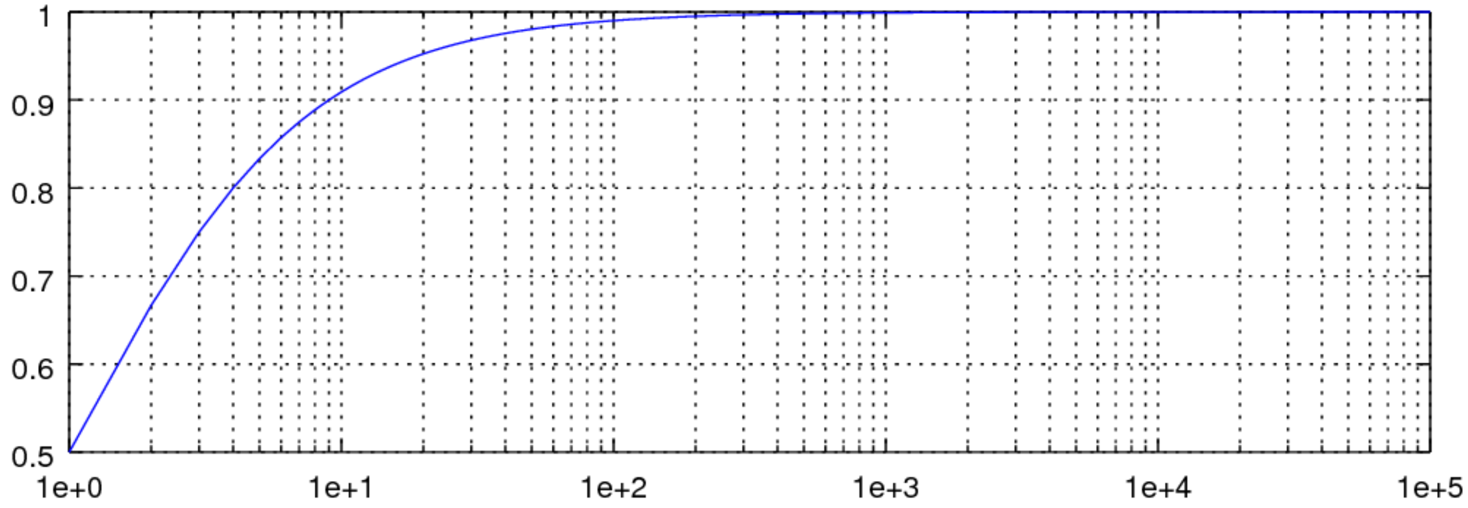
$$i = \frac{1}{1 + \frac{R_L}{R_N}} i_N$$

$R_N \gg R_L$

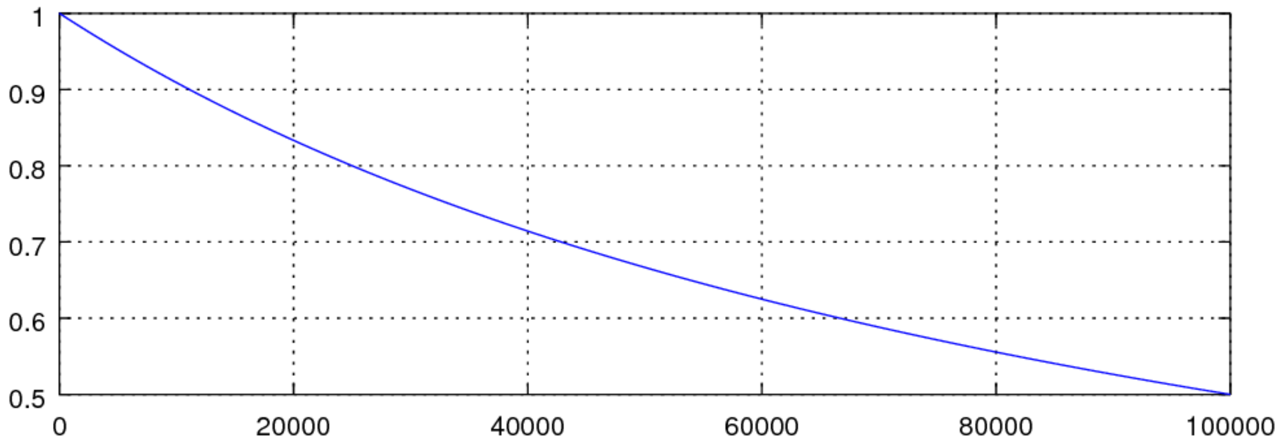


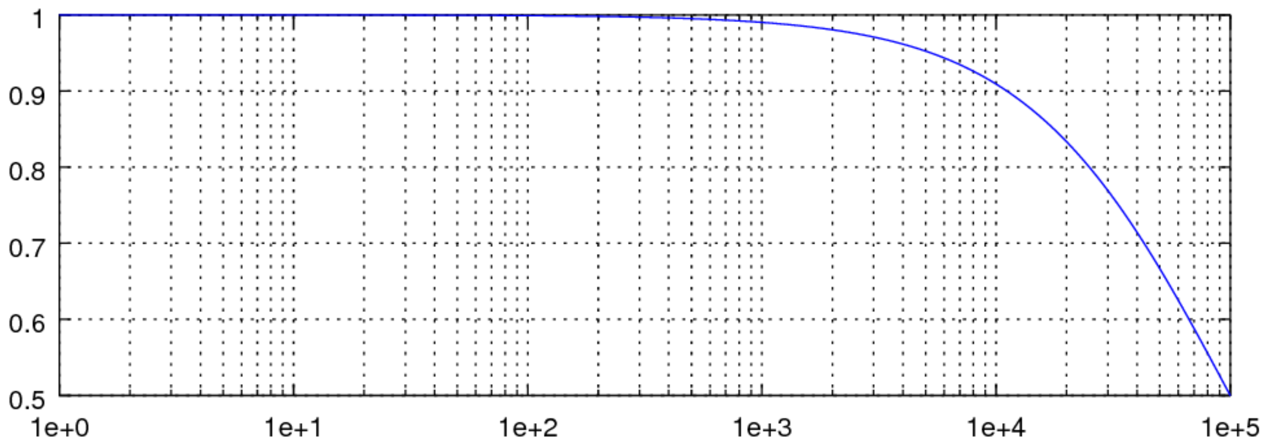






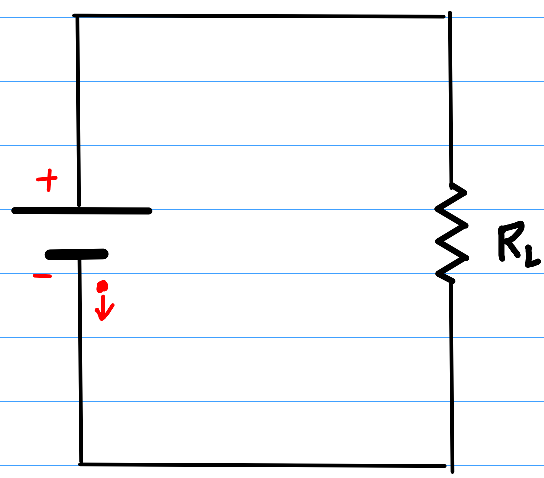

```
>> k = 1 : 100000;
>> v = k ./ (k+1);
>> subplot(2, 1, 1)
>> plot(k,v)
>> axis([0 1000]);
>> grid
>> subplot(2, 1, 2);
>> semilogx(k, v);
>> grid
```

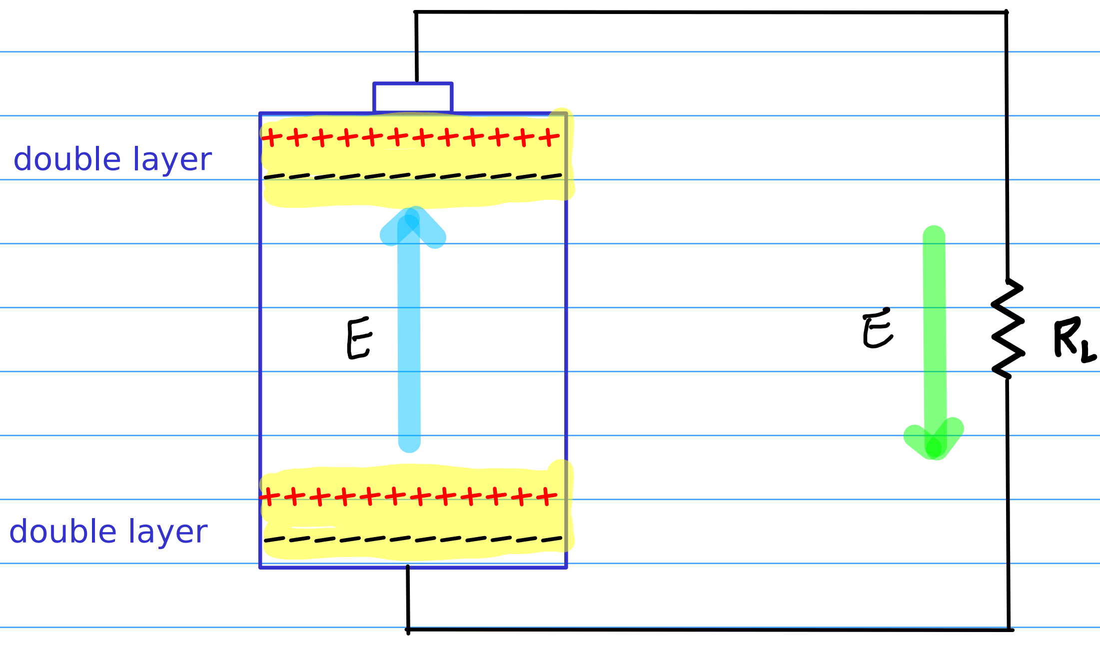





```
>> subplot(2, 1, 1);
>> k = 1 : 10000;
>> i = 100000./ (100000 +k);
>> plot(k, i);
>> k = 1 : 10: 100000;
>> i = 100000./ (100000 +k);
>> plot(k, i);
>> subplot(2, 1, 2);
>> semilogx(k, i);
>> grid
>> subplot(2, 1, 1);
>> grid
```

Electric field inside a battery





Passive Sign Convention

electric power flowing out of an active component
into an pass component

active component - battery - negative power dissipation
passive component - resistor - positive power dissipation

the direction of V and I

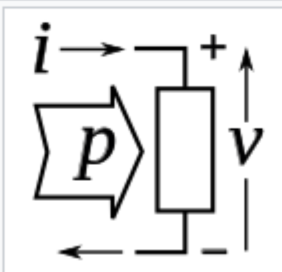


Illustration of the "*reference directions*" of the current (***i***), voltage (***v***), and power (***p***) variables used in the passive sign convention. If positive current is defined as flowing into the terminal which is defined to have positive voltage, then positive power represents electric power flowing into the device (*big arrow*).

positive current i flowing
into the terminal with +v

positive power flowing into
the device (passive component)

i : defined as entering the device
through the terminal which has +v

the power $p = iv$ $r = v/i$

i : defined as entering the device
through the terminal which has -v

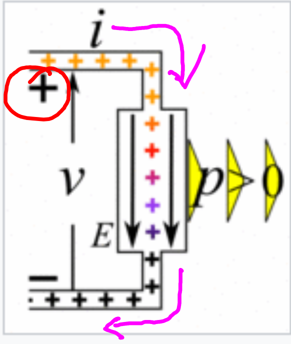
the power $p = -iv$ $r = -v/i$

passive components (loads) : $p>0$, $r>0$

active components (sources) : $p<0$, $r<0$

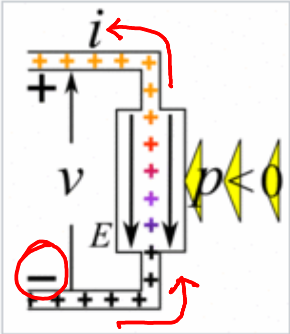
Active and passive components [edit]

In electrical engineering, power represents the rate of electrical energy flowing into or out of a given component or control volume. Power is a signed quantity; negative power just represents power flowing in the opposite direction from positive power. From the standpoint of power flow, electrical components in a circuit can be divided into two types:[2]



dissipation p>0

Load (passive component)



generation p<0

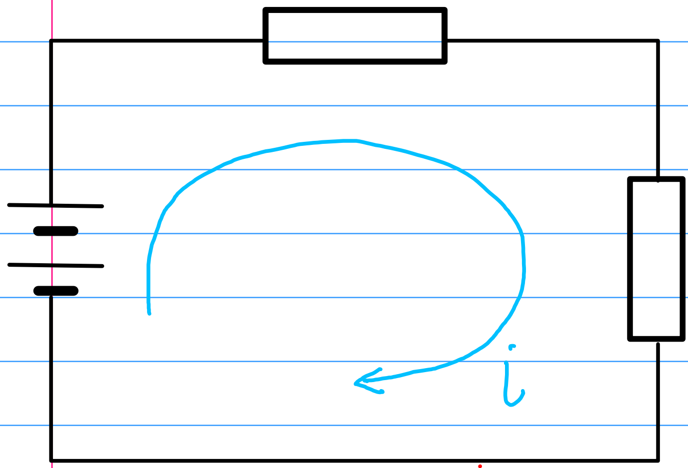
Power source (active component)

- In a *load* or *passive* component, such as a light bulb, resistor, or electric motor, electric current (flow of positive charges) moves through the device under the influence of the electric field *E* in the direction of lower electric potential, from the positive terminal to the negative. So work is done *by* the charges *on* the component; potential energy flows out of the charges; and electric power flows from the circuit into the component, where it is converted to some other form of energy such as heat or mechanical work.
- In a *source* or *active* component, such as a battery or electric generator, current is forced to move through the device in the direction of greater electric potential, from the negative to the positive voltage terminal. This increases the potential energy of the electric charges, so electric power flows out of the component into the circuit. Work must be done *on* the moving charges by some source of energy in the component, to make them move in this direction against the opposing force of the electric field *E*.

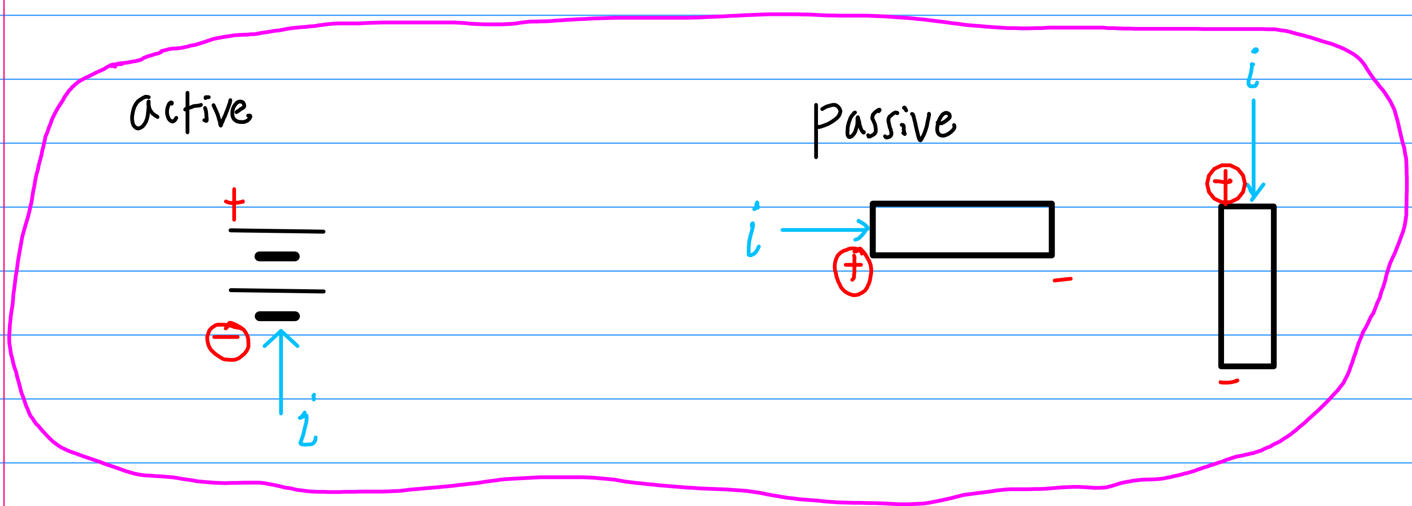
Some components can be either a source or a load, depending on the voltage or current through them. For example, a rechargeable battery acts as a source when it is used to produce power, but as a load when it is being recharged.

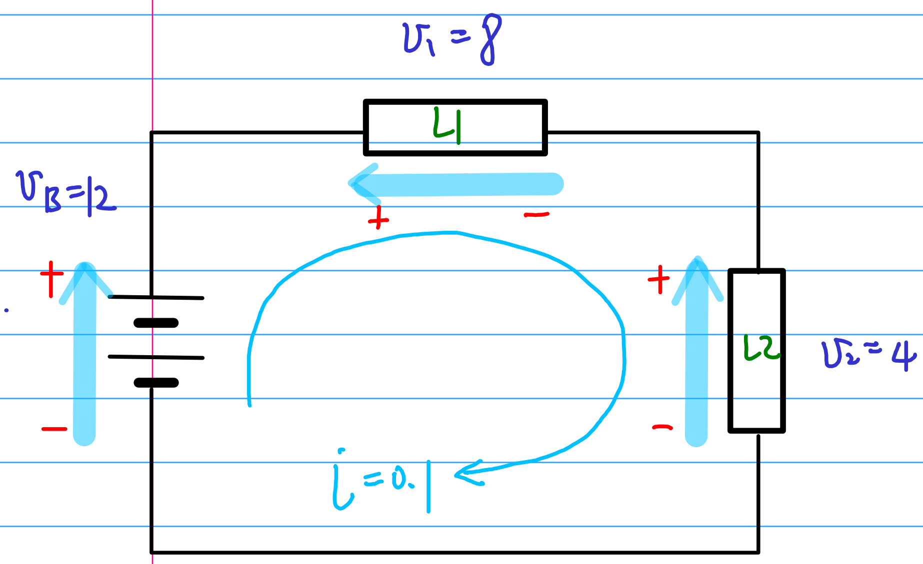
Since it can flow in either direction, there are two possible ways to define electric power; two possible *reference directions*: either power flowing into the circuit, or power flowing out of the circuit, can be defined as positive.[2] Whichever is defined as positive, the other will be negative. The passive sign convention arbitrarily defines power flowing *out* of the circuit (*into* the component) as positive,[2] so passive components have "positive" power flow.

In an AC (alternating current) circuit the current and voltage switch direction periodically, but the definitions above still apply; in passive components the current flows from the positive terminal to the negative, while in active components it flows the other direction.



assumed i





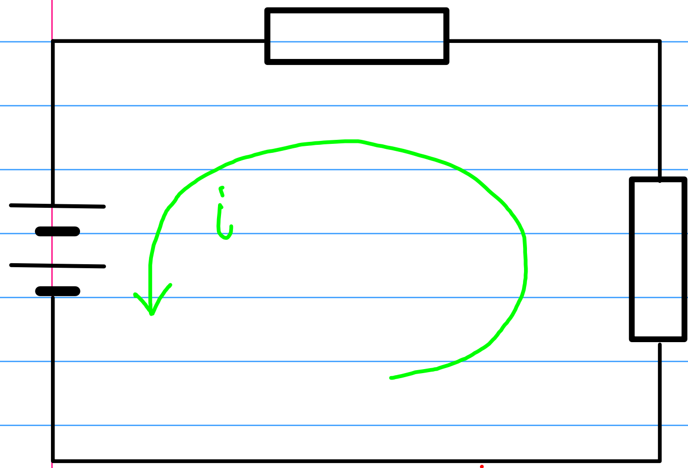
$P_1 = i \cdot v_1 = 0.1 \times 8 = 0.8$

$P_2 = i \cdot v_2 = 0.1 \times 4 = 0.4$

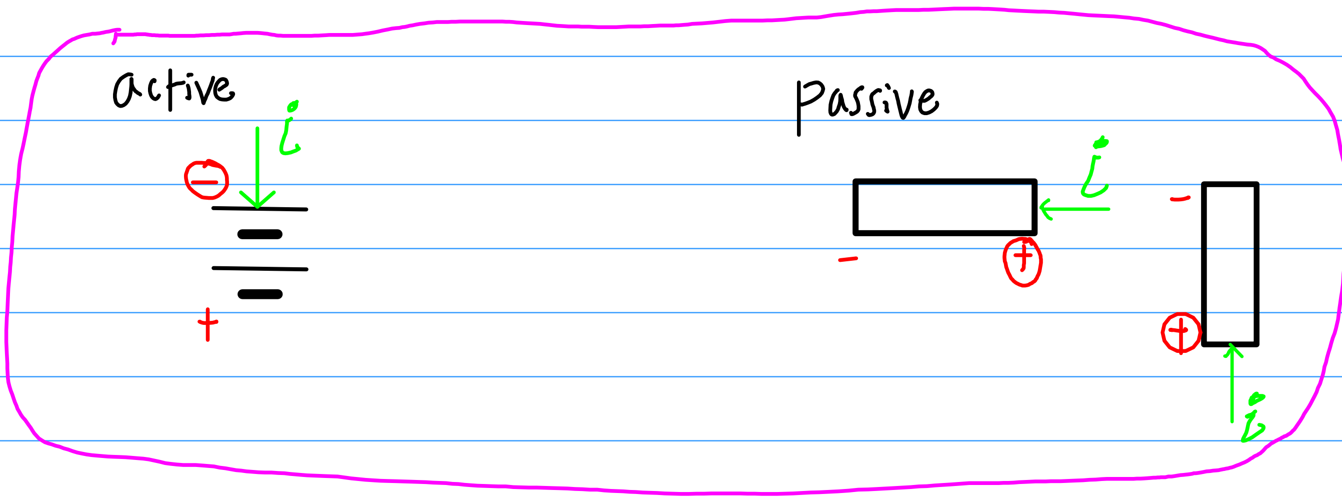
dissipated

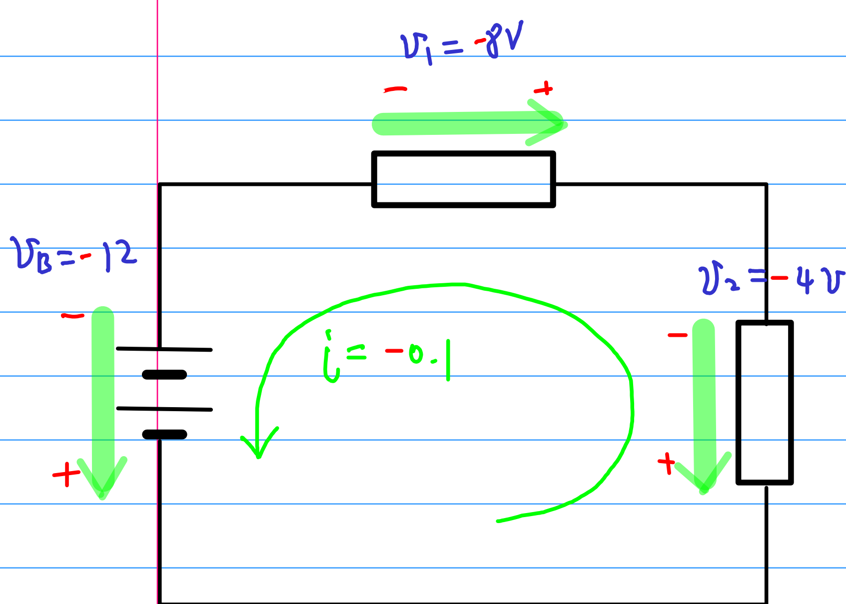
$P_B = i \cdot (-v_B) = 0.1 \times (-12) = -1.2$

generated



assumed i





$p_1 = i \cdot v_1 = (-0.1) \times (-8) = 0.8$

$p_2 = i \cdot v_2 = (-0.1) \times (-4) = 0.4$

dissipated

$p_B = i \cdot (-v_B) = (-0.1) \times (+12) = -1.2$

generated