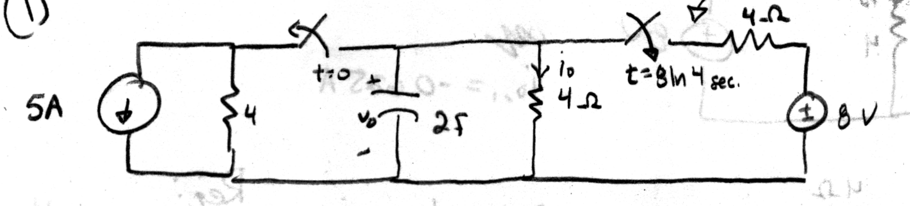
① Review Questions by J.O.

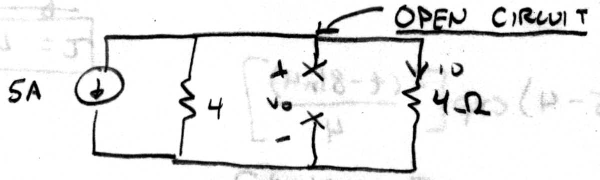
(1)



Hmmm... 8ln4 ... why did Justin pick that???

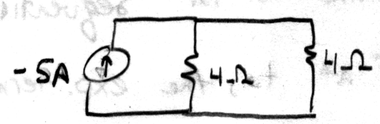
Find $v_o(t)$ & $i_o(t)$ for $t>0$ & Plot $i_o(t)$

Let's assume the circuit has been as drawn (before any switching) for a very long time



How to find v_o & i_o?

(a.) Current Divider



$i_o = (-5A)\frac{4}{4+4} = \underline{-2.5A}$

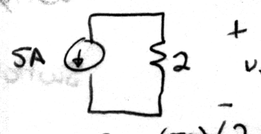
$v_o = (-2.5A)(4) = \underline{-10V}$

(b.) Transform & Voltage Divider

$i_o = -20/8 = \underline{-2.5A}$

$v_o = -20\left(\frac{4}{4+4}\right) = \underline{-10V}$

(c.) ∥ Res.



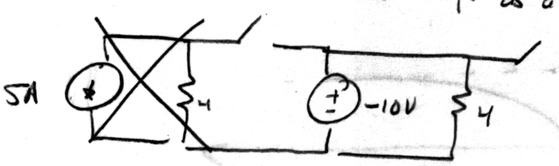
Note: i_o is gone here!

$v_o = -(5A)(2\Omega) = \underline{-10V}$ (Negative sign convention)

$i_o = \frac{v_o}{4} = \underline{-2.5A}$

$0 \le t < 8\ln 4$: v_o does not instantaneously jump ⇒ i_o does not jump, since $i_o = \frac{v_o}{4}$

Model capacitor as a voltage source @ $t=0^+$



$\boxed{v_{o,0} = -10V \quad i_{o,0} = -2.5A}$

$R_{eq} = 4\Omega$

$\tau = R_{eq}C_{eq} = \boxed{8s}$

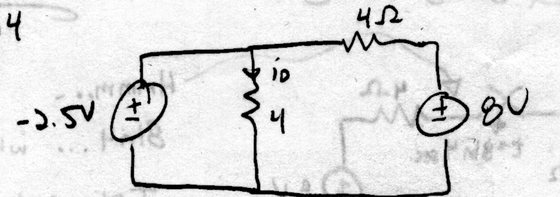
Now, imagine the 2nd switch never goes off. $\boxed{v_{o,\infty} = 0V \quad i_{o,\infty} = 0A}$

So, for $0 \le t < 8\ln 4$: $v_o(t) = -10\exp\left[-t/8\right]$ (V)

$i_o(t) = -2.5\exp\left[-t/8\right]$ (A)

What are $v_o(8\ln 4)$? & $i_o(8\ln 4)$? → $\boxed{v_o(8\ln 4) = -2.5\ V \quad i_o(8\ln 4) = -0.625\ A}$

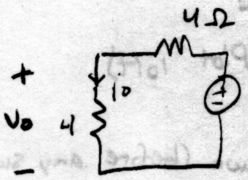
$t \geq 8\ln 4$



$V_{o,p} = -2.5V$

$i_{o,1} = -0.625\,A$

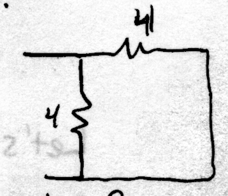
$t \to \infty$



Voltage Divider!

$$\boxed{\begin{array}{l} V_{o,\infty} = 8V\left(\frac{4}{4+4}\right) = 4V \\ i_{o,\infty} = \frac{8V}{8\,\Omega} = 1A \end{array}}$$

Req:



|| → Res

$R_{eq} = 2\,\Omega$

$\boxed{\tau = 4\,s}$

for $t > 8\ln 4$

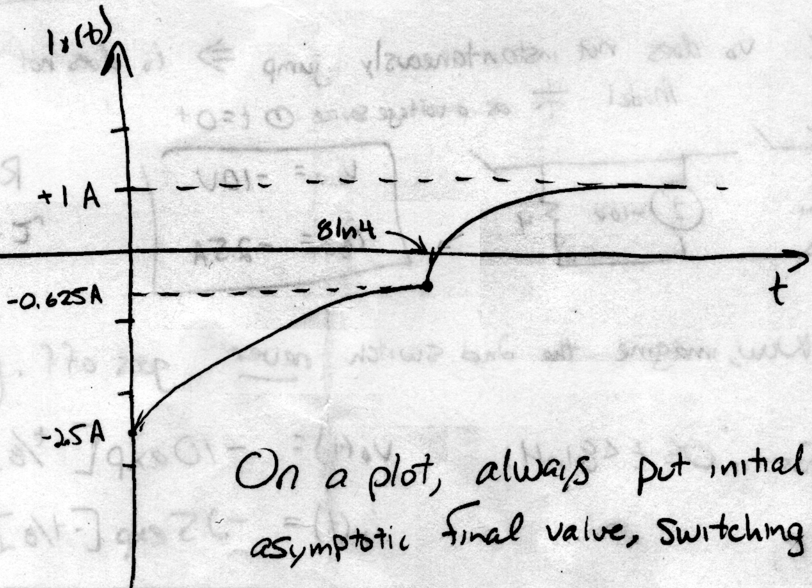
$$V_o(t) = 4 + (-2.5 - 4)\exp\left[\frac{-(t - 8\ln 4)}{4}\right]$$

$$i_o(t) = 1 + (-0.625 - 1)\exp\left[\frac{-(t - 8\ln 4)}{4}\right]$$

Why the $-8\ln 4$ term? → Always have this for sequential switching → whenever a switch goes off at t_0, the exp. term is $\exp\left[\frac{-(t - t_0)}{\tau}\right]$

So...

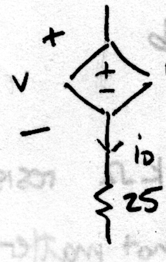
PLOT



On a plot, always put initial value, asymptotic final value, switching time, & value @ switch.

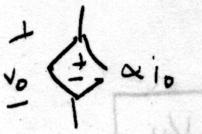
C. Look at Dependent Source

$V = 5i_0$



Voltage is dependent on its own current

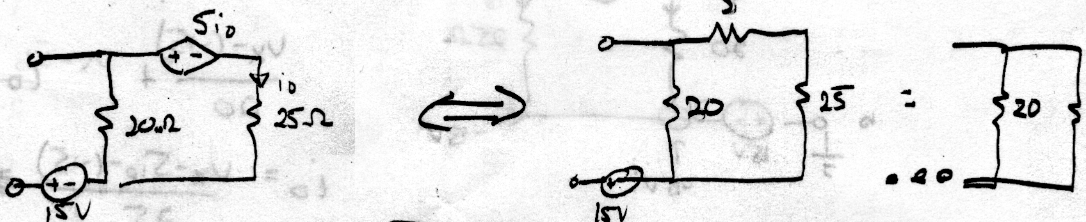
... **LIKE A RESISTOR!!!**

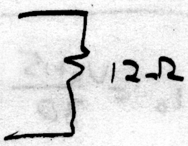


$V_0 = \alpha i_0 \iff v = iR$

$\underline{\alpha = R}$

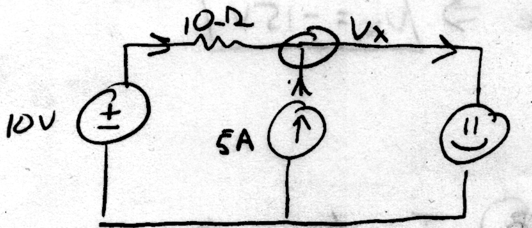
So





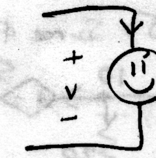
$\boxed{R_{eq} = 12\ \Omega}$

3.)



Set up nodal equation(s) for v_x.

where



has the i-v relationship: $i = v \cdot \exp\left[(\arctan v)^{-1/2} + \mathrm{erf}(v)\right]$

One equation, one unknown:

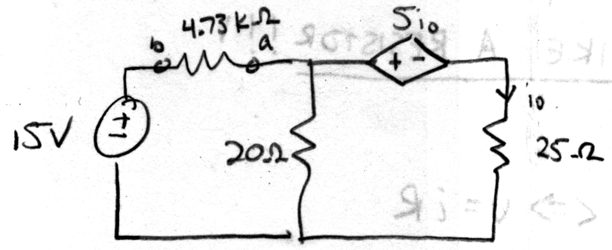
$$\frac{10 - v_x}{10} + 5 = v_x \cdot \exp\left[(\arctan v_x)^{-1/2} + \mathrm{erf}(v_x)\right]$$

That's it. You're done!

If you want to solve for v_x, come to my OH and I'll beat you over the head with a blunt object!

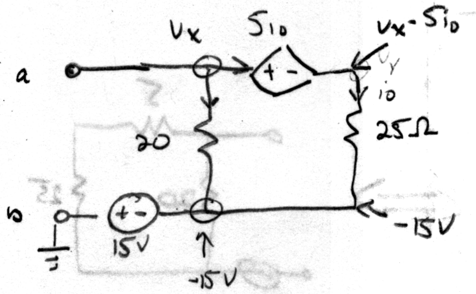
3

(2.) Thevenin Equivalent around terminals a & b



The 4.73kΩ resistor does not matter!

Redraw:



$\boxed{\text{Find } v_x = V_{th}}$

Nodal analysis around v_x

$$\frac{v_x-(-15)}{20} + i_o = 0$$

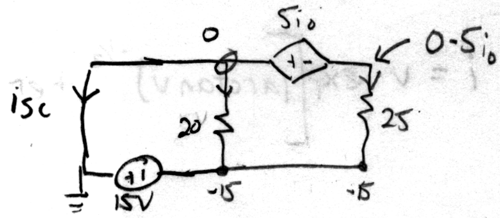
$$i_o = \frac{v_x - 5i_o - (-15)}{25} \Rightarrow 25 i_o = v_x - 5 i_o + 15$$

$$i_o = \frac{v_x+15}{30}$$

$$\frac{v_x+15}{20} + \frac{v_x+15}{30} = 0 \rightarrow \text{Solve} \Rightarrow \boxed{v_x = -15V}$$

R_{eq}: 3 Methods

(A) Find $i_{sc} \rightarrow R_{eq} = V_{th}/I_{sc}$

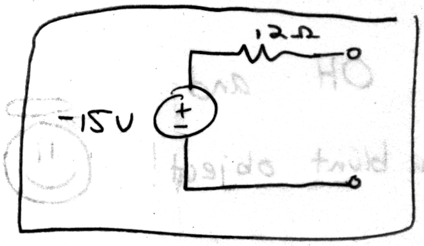


$$\frac{0-5i_o+15}{25} = i_o \Rightarrow i_o = \underline{0.5}$$

Node at what was v_x! $i_{sc} + 0.5 + \frac{15}{20} = 0$

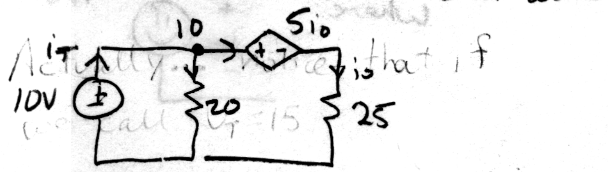
$i_{sc} = -1.25$

$R_{eq} = -15/-1.25 = \underline{12\,\Omega}$



(B) I_{test}/V_{test} Method

Kill 15V source & add a 10 volt source



KVL: $10 - 5i_o - 25i_o = 0 \Rightarrow i_o = \frac{1}{3}$

$i_T = \frac{10}{20} + \frac{1}{3} \Rightarrow \underline{i_T = 5/6}$

$R_{eq} = V_T/i_T = 10/(5/6) = 12\,\Omega$