U.B.A. FACULTAD DE INGENIERÍA

Departamento de Electrónica

LABORATORIO 66-02
Informática

TRABAJO PRÁCTICO N°0

Análisis de circuitos

Curso 2021 – 1er Cuatrimestre

GRUPO N° 6
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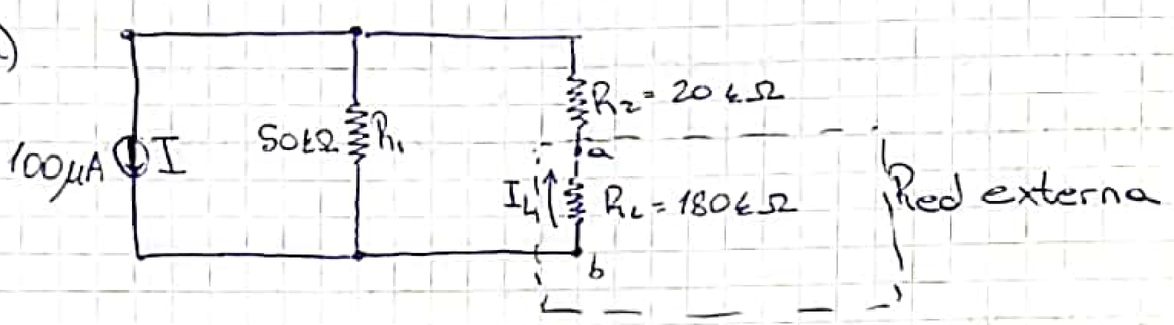
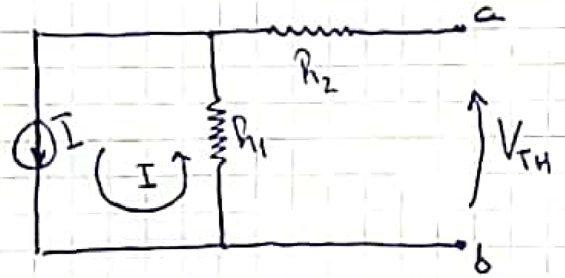
Observaciones:

1) Obtenga los valores indicados en cada circuito sobre R_L, aplicando los teoremas de Thevenin y de Norton

a)



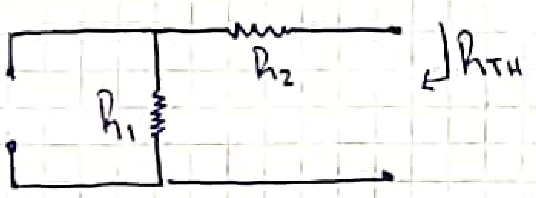
Buscamos la tensión de Thevenin:



Sobre R_2 no circula corriente entonces $V_{TH} = V_{R_1} = I \cdot R_1$

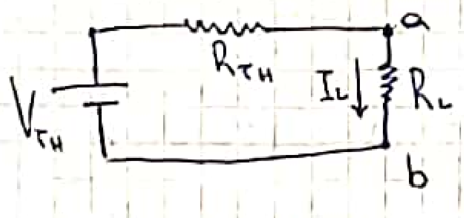
$V_{TH} = 100\mu A \cdot 50k\Omega = 5V$

Para encontrar R_{TH} debemos pasivar la fuente de corriente:



$R_{TH} = R_1 + R_2 = 70k\Omega$

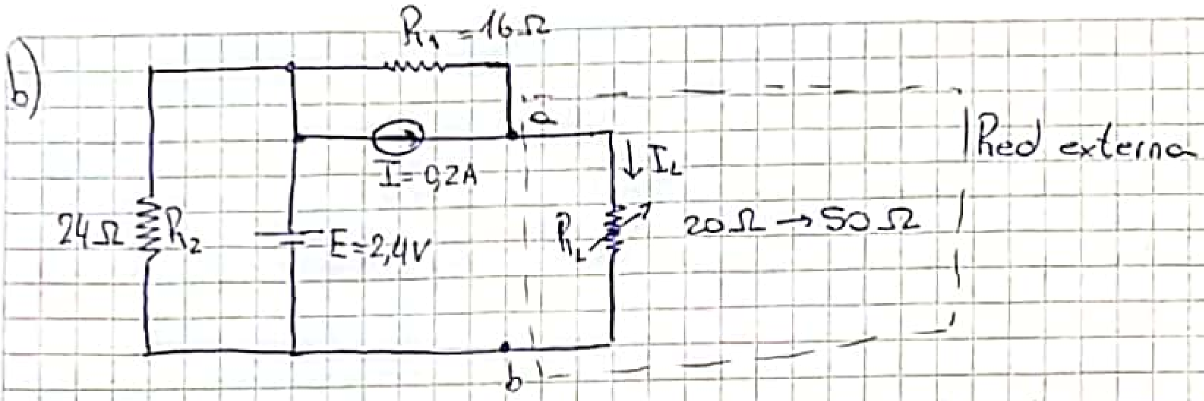
Luego, el siguiente circuito es el que se obtiene por el T. de Thevenin:



$$I_L = \frac{V_{TH}}{R_L + R_{TH}} = \frac{5V}{180k\Omega + 70k\Omega} = 20\mu A$$

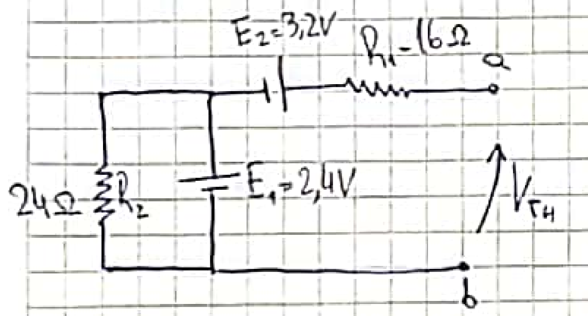
$$\boxed{I_L = 20\mu A}$$

b)



Reemplazamos la fuente de corriente y la resistencia que están en paralelo por su equivalente de Thevenin.

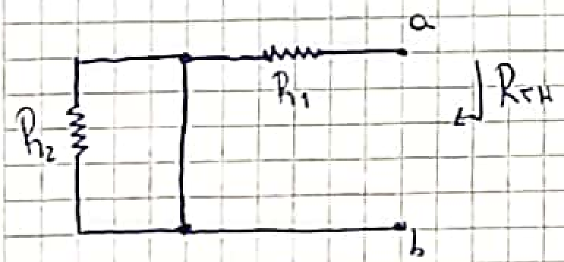
Buscamos V_{TH}:



$E_2 = 16\,\Omega \cdot 0{,}2\,A = 3{,}2\,V$

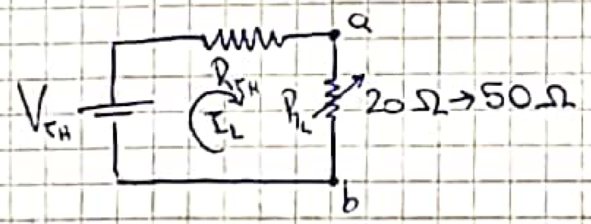
$V_{TH} = E_1 + E_2 = 5{,}6\,V$

Buscamos R_{TH}:



$R_{TH} = R_1 = 16\,\Omega$

Entonces, por el teorema de Thevenin se obtiene el siguiente circuito:



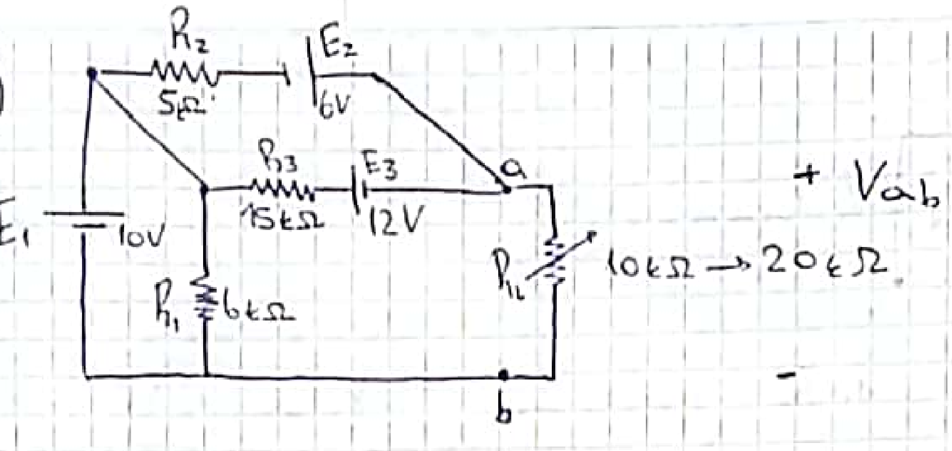
$I_L = \dfrac{V_{TH}}{R_{TH} + R_L}$ entonces, para $R_L = 20\,\Omega$: $I_L = \dfrac{5{,}6\,V}{(16+20)\,\Omega} = \boxed{0{,}156\,A}$

y $\boxed{V_{ab} = 3{,}12\,V}$

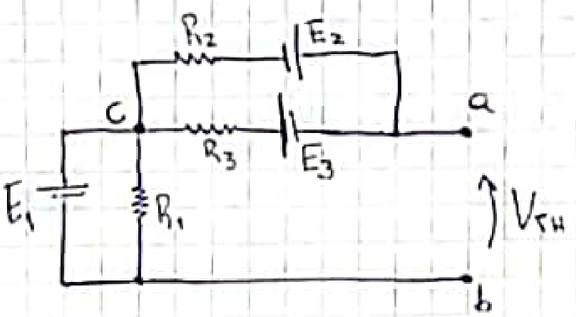
para $R_L = 50\,\Omega$: $I_L = \dfrac{5{,}6\,V}{(16+50)\,\Omega} = \boxed{0{,}0848\,A}$

y $\boxed{V_{ab} = 1{,}70\,V}$

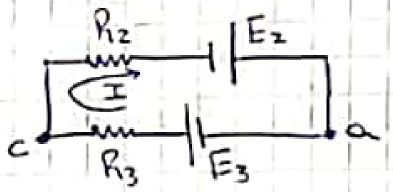
c)



Buscamos V_{TH}:



$V_{TH} = E_1 + V_{ac}$



$E_3 + E_2 - I\,(R_2 + R_3) = 0$

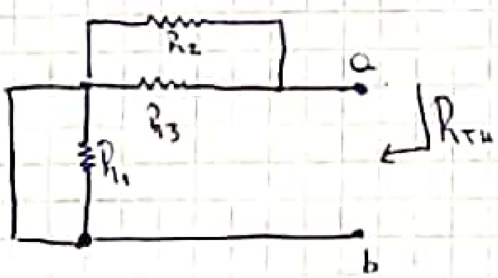
$\Rightarrow I = \dfrac{E_2 + E_3}{R_2 + R_3} = \dfrac{18\,V}{20\,k\Omega} = 9 \times 10^{-4} A$

$= 0{,}9\,mA$

Entonces $V_{ac} = -0{,}9\,mA \times R_2 + E_2 = 1{,}5V$

$V_{TH} = E_1 + V_{ac} = 10\,V + 1{,}5\,V = 11{,}5\,V$

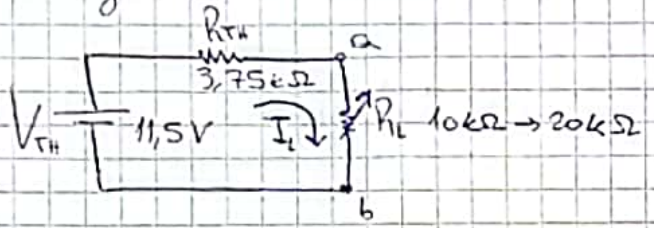
Buscamos R_{TH}:



$R_{TH} = R_2 \,||\, R_3 = \left(\dfrac{1}{R_2} + \dfrac{1}{R_3} \right)^{-1}$

$R_{TH} = \dfrac{R_2 R_3}{R_2 + R_3} = 3{,}75\,k\Omega$

Luego, el circuito que se obtiene por el teorema de Thevenin es el siguiente:



$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

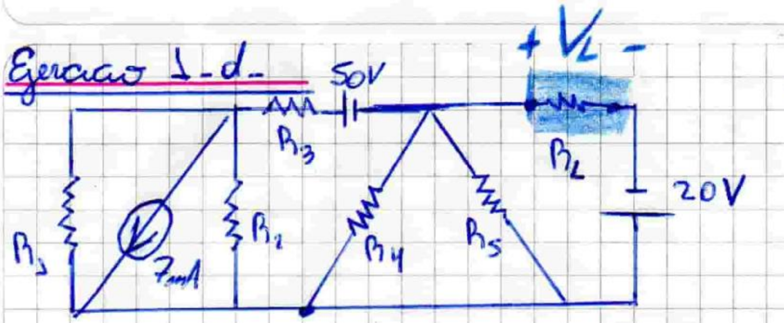
si $R_L = 10\,k\Omega$: $I_L = \frac{11,5\,V}{(3,750+10)\,k\Omega} = \boxed{0,836\,mA}$

$$V_{ab} = I_L \times R_L = \boxed{8,36\,V}$$

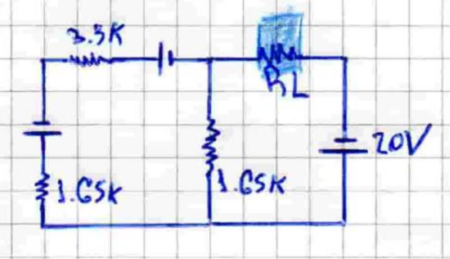
si $R_L = 20\,k\Omega$: $I_L = \frac{11,5\,V}{(3,75+20)\,k\Omega} = \boxed{0,484\,mA}$

$$V_{ab} = I_L \times R_L = \boxed{9,68\,V}$$

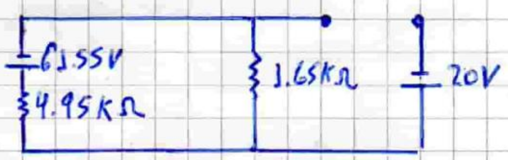
Ejercicio 1-d-



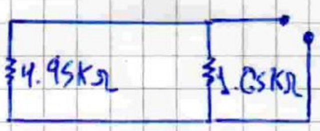
Todas las resistencias son de 3.3KΩ



Mi Red lineal actual:



Busco RTH: pasivo fuentes

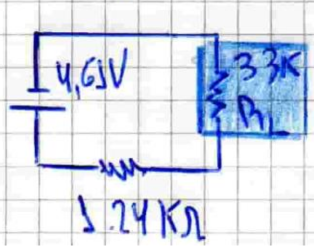


$$R_{TH} = 4.95K\Omega // 1.65K\Omega = 1.24K\Omega$$

Busco V_{TH}

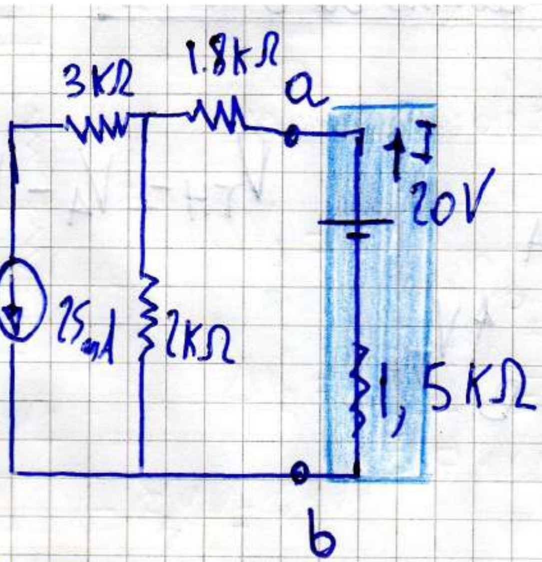
$$V_{TH} = -20V + 61.55V \cdot \frac{1.65K\Omega}{4.95K\Omega + 1.65K\Omega} = -4,61V$$

Circuito equivalente:



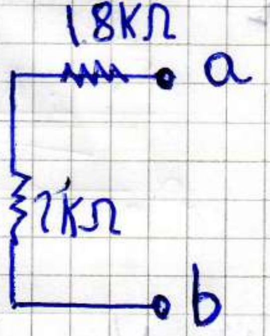
$$V_L = -4.61V \cdot \frac{3.3K\Omega}{3.3K\Omega + 1.24K\Omega} = -3.35V$$

Ejercicio 1-e-



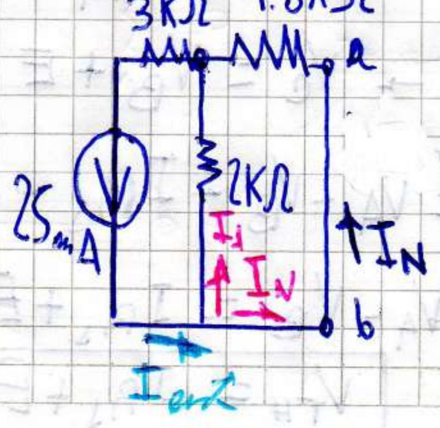
Voy a usar el T de Norton.

Hallo la R_N



$$\boxed{R_N = 3.8K\Omega}$$

Hallo la I_N



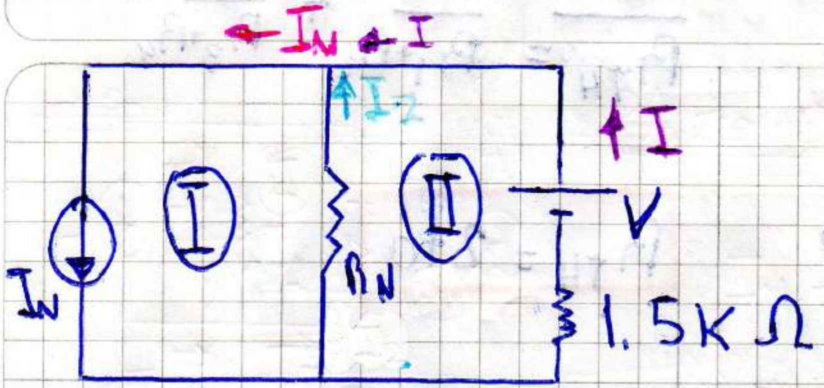
Uso DIVISOR DE CORRIENTE

$$I_N = I_{ent} \cdot \frac{2K\Omega}{1.8K\Omega + 2K\Omega}$$

$$I_N = 25mA \cdot \frac{10}{19} = 13,16\,mA$$

$$\boxed{I_N = 13,16\,mA}$$

Planteo Leyes de Kirchoff



1) $I_N = I + I_2$

$I_2 = I_N - I$ → ya lo teng

2) I ↻ $-1{,}5k\Omega I + V + I_2 R_N = 0$

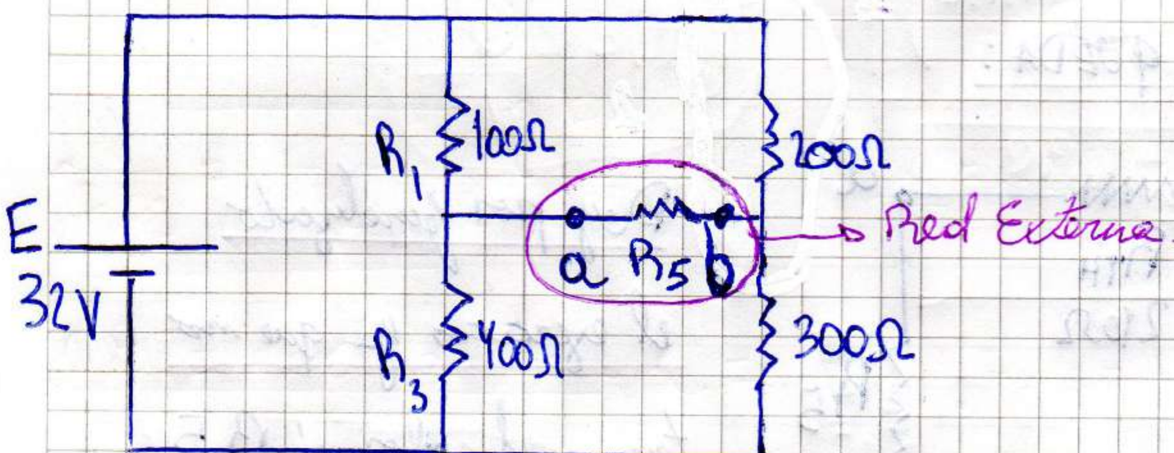
$$-1{,}5k\Omega \cdot (I) + V + (I_N - I) R_N = 0$$

$$-1{,}5k\Omega I + 20V + (13{,}16mA - I)\, 3{,}8k\Omega = 0$$

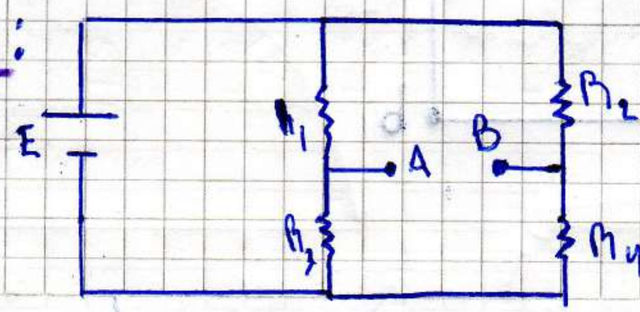
$$+20V + 50V - 5{,}3k\Omega I = 0$$

$$\boxed{I = 13{,}20\,mA}$$

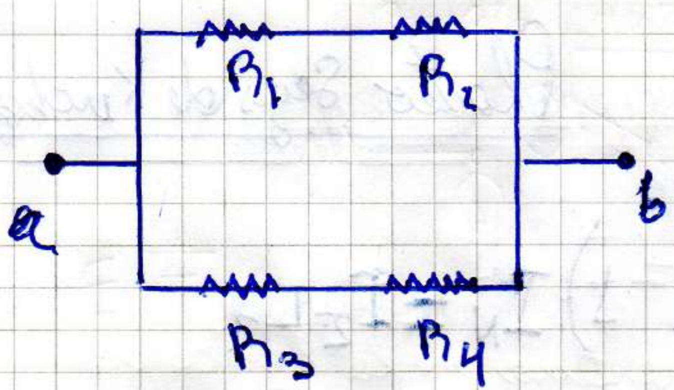
Ejercicio 1-6.



Red lineal activa:



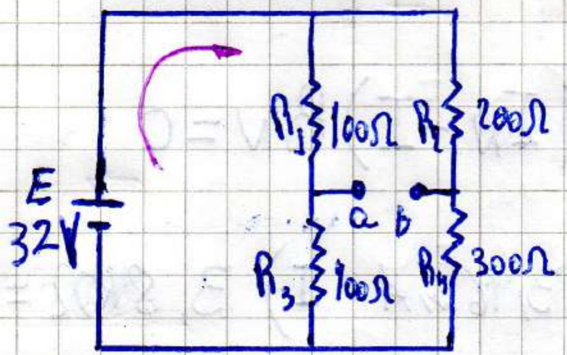
Busco la R_{TH}



$$\frac{1}{R_{TH}} = \frac{1}{R_1+R_2} + \frac{1}{R_3+R_4}$$

$$\boxed{R_{TH} = 210}$$

Busco la V_{TH}



Hago un divisor de tensión

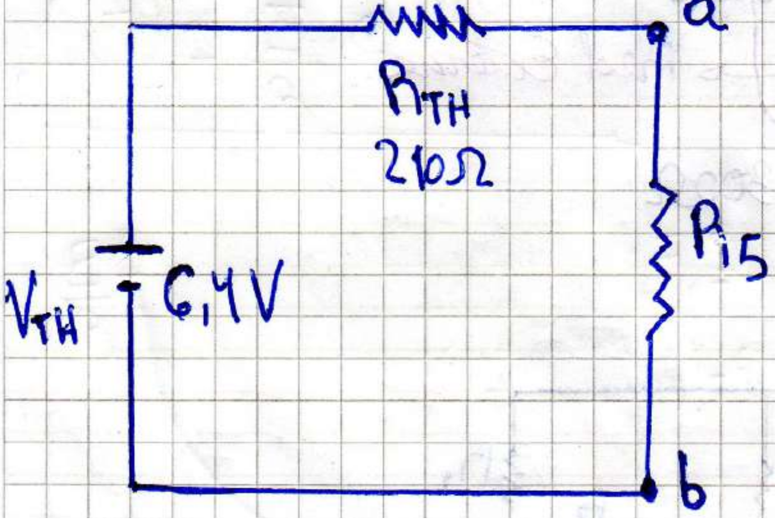
$$\Delta V_1 = \frac{R_1}{R_1+R_3} E = \frac{32}{5} V = 6,4V$$

$$\Delta V_2 = \frac{R_2}{R_2+R_4} E = \frac{64}{5} V = 12,8V$$

$$V_{TH} = V_a - V_b = 12,8V - 6,4V = 6,4V$$

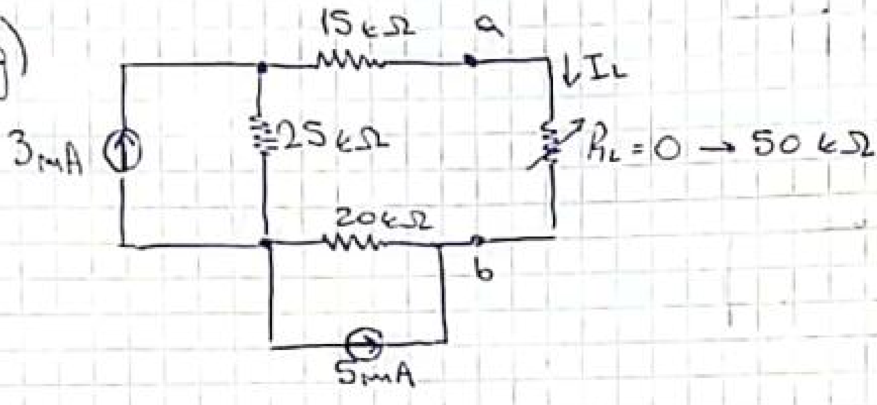
$$\boxed{V_{TH} = 6,4V}$$

MI CIRCUITO QUEDA:

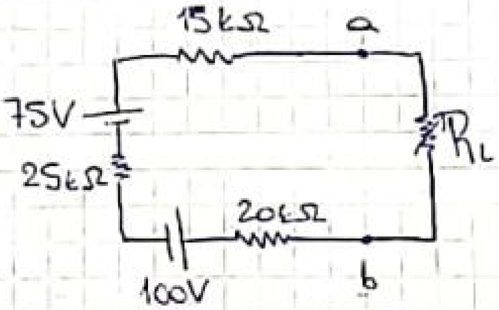


Doy por finalizado el ejercicio ya que no tengo el valor de R5.

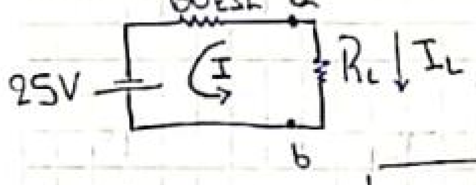
1) g)



Podemos reemplazar aquellas fuentes de corriente que tienen una resistencia en paralelo por su equivalente de Thevenin:



Podemos simplificar el circuito sumando las fuentes y las resistencias

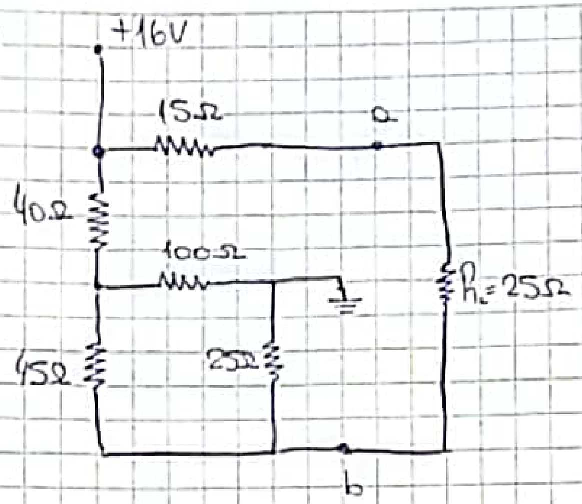


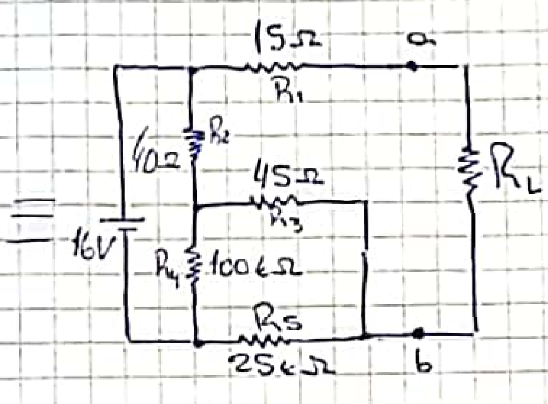
$$I_L = \frac{-25V}{60k\Omega + R_L}$$

Si $R_L = 0 \rightarrow \boxed{I_L = -0{,}4167\ mA}$

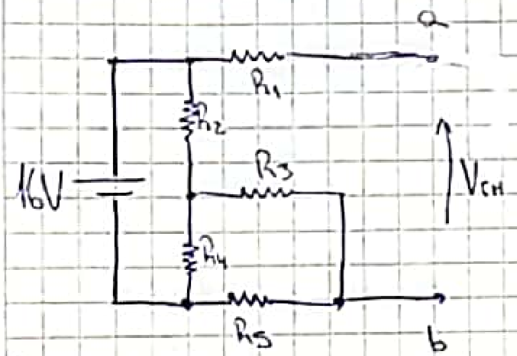
Si $R_L = 50k\Omega \rightarrow \boxed{I_L = -0{,}2273\ mA}$

1-h)





Buscamos V_{TH}:

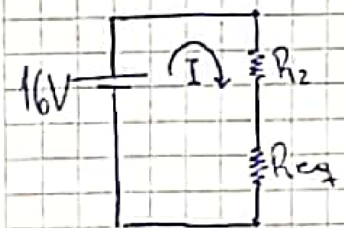


$$V_{TH} = V_{R_5} + 16V$$

$$R_{eq} = R_4 \parallel (R_3 + R_5)$$

$$R_{eq} = \left(\frac{1}{R_4} + \frac{1}{R_3+R_5}\right)^{-1} = 41,2\,\Omega$$

Entonces, tenemos:



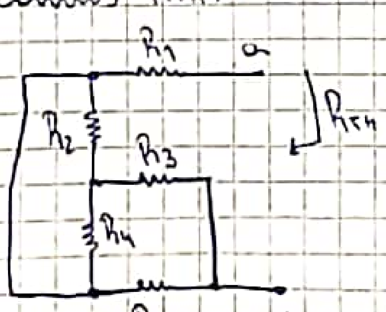
$$V_{R_2} = 16V \cdot \frac{R_2}{R_2+R_{eq}} = 7,88\,V$$

$$V_{R_4} + V_{R_2} = 16V \Rightarrow V_{R_4} = 8,12\,V$$

$$V_{R_5} = -V_{R_4} \cdot \frac{R_5}{R_3+R_4} = -2,9\,V$$

$$\Rightarrow V_{TH} = -2,9\,V + 16\,V = 13,1V$$

Buscamos R_{TH}:



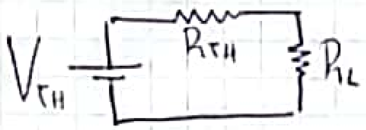
$$R_{TH} = R_1 + \left[(R_2 \parallel R_4) + R_3\right] \parallel R_5 =$$

$$= 15\,\Omega + \left[28,57\,\Omega + 45\,\Omega\right] \parallel 25\,\Omega =$$

$$= 15\,\Omega + 73,57\,\Omega \parallel 25\,\Omega = 33,7\,\Omega$$

$$R_{TH} = 33,7\,\Omega$$

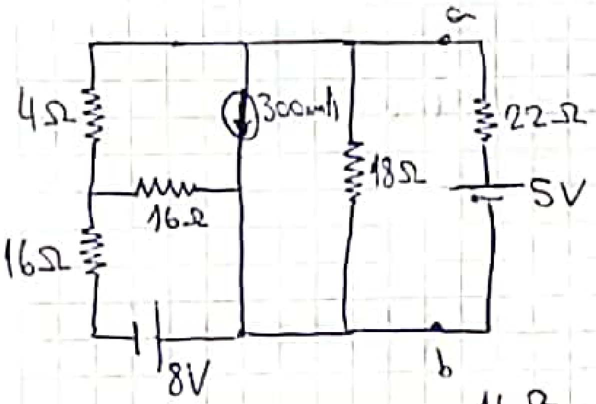
A partir del teorema de Thevenin se obtiene el siguiente circuito:



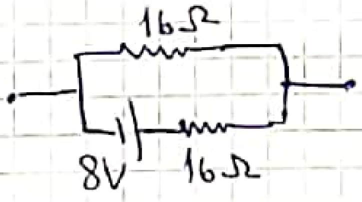
$$I_{R_L} = \frac{V_{TH}}{R_{TH}+R_L} = \frac{13,1\ V}{33,7\Omega + 25\Omega} = \boxed{0,22A}$$

$$V_{R_L} = V_{TH} \cdot \frac{R_L}{R_{TH}+R_L} = \boxed{5,58V}$$

i) El siguiente circuito es equivalente al del enunciado

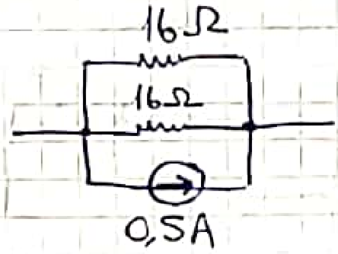


Vemos que

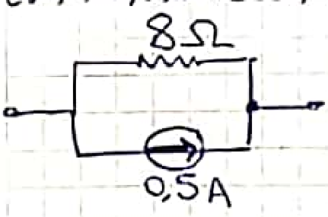


puede ser simplificado

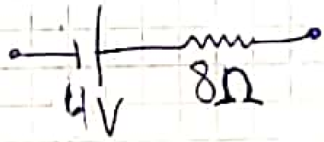
Buscamos el equivalente de Norton:



Las resistencias estan en paralelo:

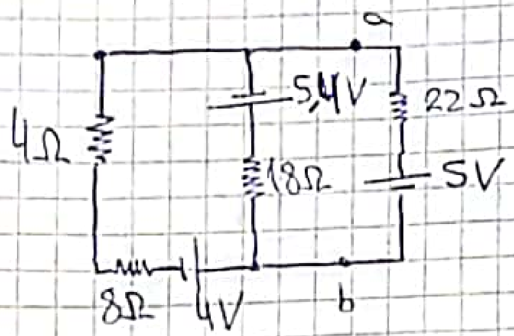


esto es equivalente a:



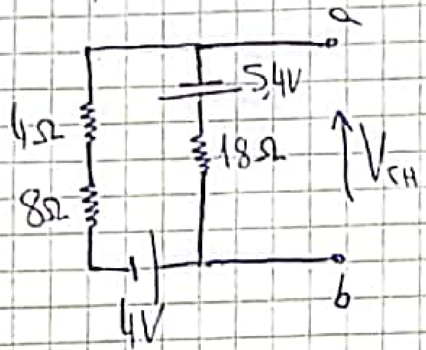
Además, en el circuito inicial hay una fuente de corriente con una resistencia en paralelo que pueden ser reemplazados por su equivalente de Thevenin.

Entonces, nos queda el siguiente circuito:



Ahora aplicamos el teorema de Thevenin

V_{TH})



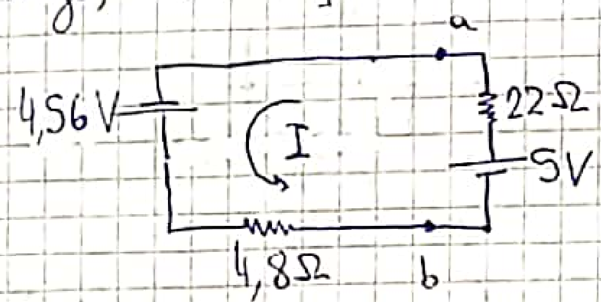
$$V_{TH} = -5,4V + \frac{(5,4V - 4V) \cdot 18\Omega}{18\Omega + 8\Omega + 4\Omega}$$

$$V_{TH} = -4,56V$$

R_{TH})

$$R_{TH} = 18\Omega \parallel (4\Omega + 8\Omega) = 4,8\Omega$$

Luego, tenemos que:

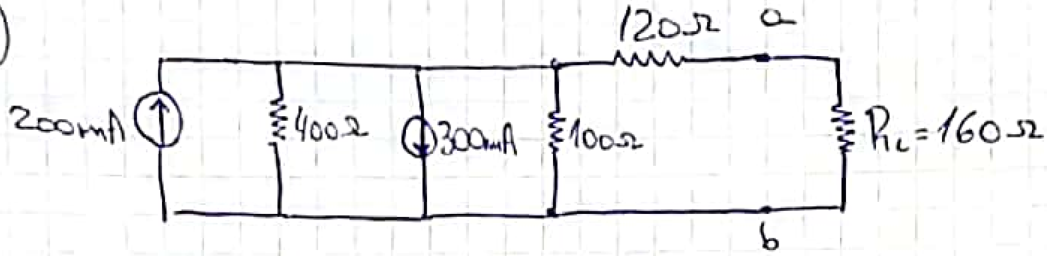


$$I = \frac{5V + 4,56V}{22\Omega + 4,8\Omega} = \boxed{0,357A}$$

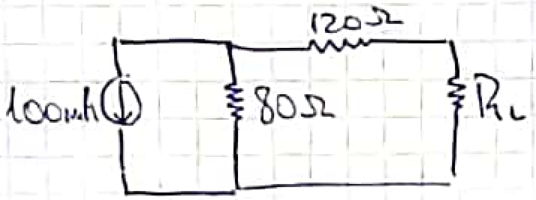
$$V_{ab} = 5V - 0,357A \times 22\Omega$$

$$\boxed{V_{ab} = -2,85V}$$

k)

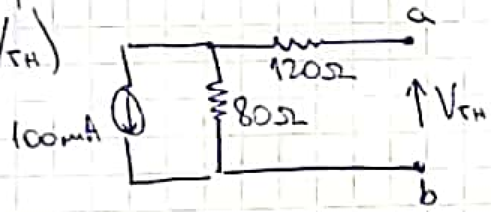


Las fuentes de corriente en paralelo pueden reducirse a una sola fuente. Y las resistencias 400Ω y 100Ω están en paralelo, entonces:



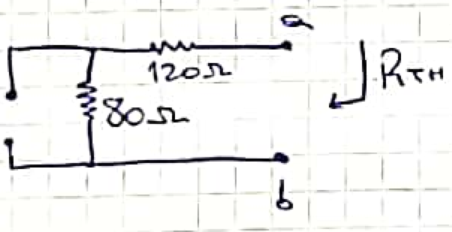
Aplicamos el teorema de Thevenin:

V_{TH})



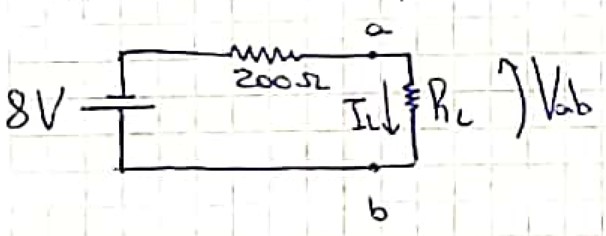
$$V_{TH} = -100\,mA \cdot 80\Omega = -8V$$

R_{TH})



$$R_{TH} = 80\Omega + 120\Omega = 200\Omega$$

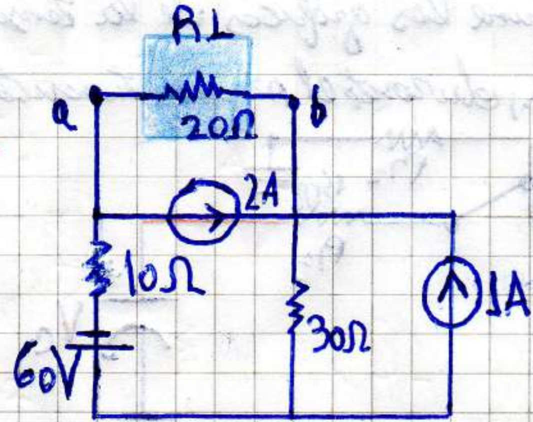
Entonces, tenemos que:



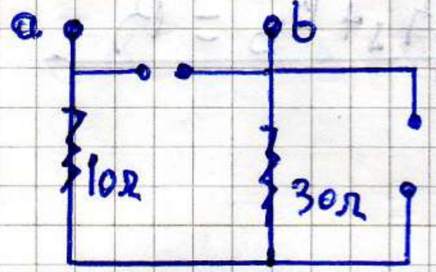
$$I_L = \frac{-8V}{200\Omega + 160\Omega} = \boxed{22,2\,mA}$$

$$V_{R_L} = V_{ab} = 8V \cdot \frac{160\Omega}{200\Omega + 160\Omega} = \boxed{3,56V}$$

Ejercicio 1-J



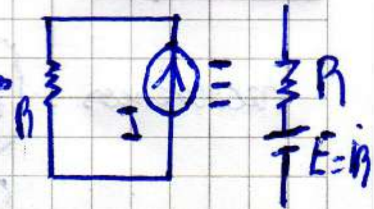
Busco R_{TH} → Pasivo fuentes.

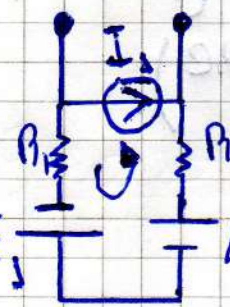


$$\boxed{R_{TH} = 10\Omega + 30\Omega = 40\Omega}$$

Busco V_{TH}

Establezco el 0 del potencial en A y uso el equivalente de Norton →





$E_2 = I_2 R_2 = 30V$

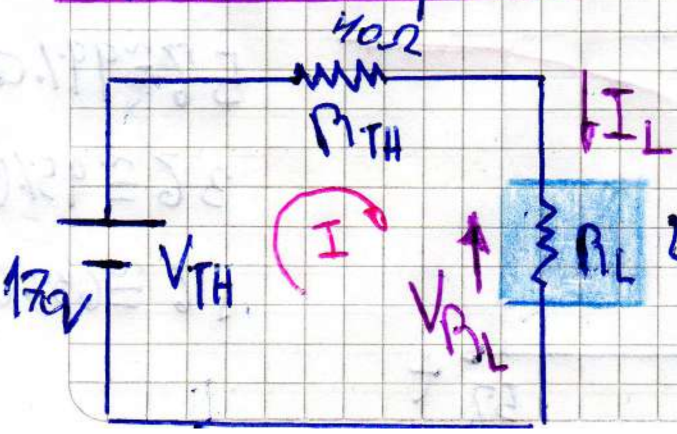
Ley de mallas de Kirchoff:

$$V_{AB} = V_{R_1} + V_{R_2} + E_1 + E_2$$

$V_{R_1} = I_1 R_1 = 2A \cdot 10\Omega = 20V$ • $V_{R_2} = 2A \cdot 30\Omega = 60V$

$$V_{TH} = V_{AB} = 20V + 60V + 60V + 30V \Rightarrow \boxed{V_{TH} = 170V}$$

MI CIRCUITO QUEDA:



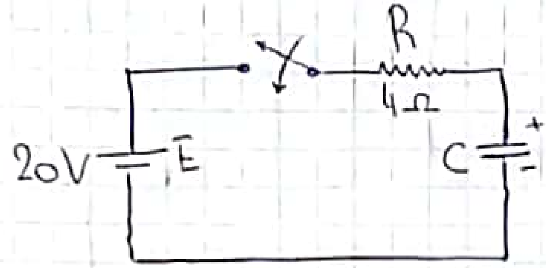
USO LEY DE OHM para sacar I_{RL}

$$170V = I \cdot (40\Omega + 20\Omega)$$

$$\boxed{I_L = 2,8\widehat{3}\,A}$$

$$\boxed{V_{RL} = 20\Omega \cdot 2,8\widehat{3}\,A = 56,\widehat{66}\,V}$$

3) a)



$C = 10\,\mu F$

Si la llave está abierta, el capacitor se mantiene descargado. Tomamos a $t=0$ como el momento en el cual se cierra la llave.

Una vez cerrada la llave tenemos que:

$$E = V_R(t) + V_c(t) \quad ; \quad V_R(t) = I(t) \cdot R = \frac{dV_c(t)}{dt} \cdot C \cdot R$$

Entonces $E = \frac{dV_c(t)}{dt} C \cdot R + V_c(t)$

$$\frac{E}{RC} = \frac{dV_c(t)}{dt} + \frac{V_c(t)}{RC}$$

Sea $\tau = RC \rightarrow \frac{E}{\tau} = \frac{dV_c(t)}{dt} + \frac{V_c(t)}{\tau}$

Propongo la solución $V_c(t) = A \cdot e^{-t/\tau} + B$

Para $t \to \infty \qquad V_c(t) = E \Rightarrow B = E$

Para $t \to 0 \qquad V_c(t) = 0 \Rightarrow A + B = 0 \Rightarrow A = -E$

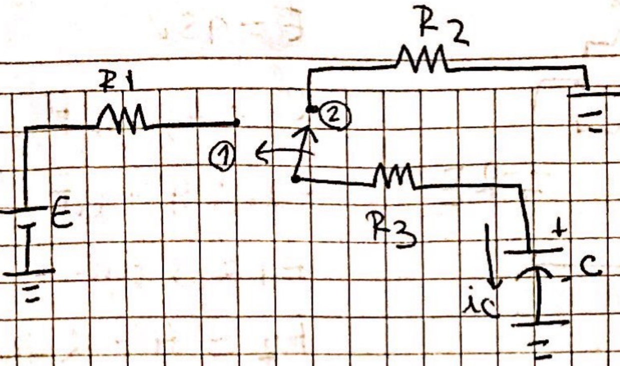
$$\Rightarrow V_c(t) = -E e^{-t/\tau} + E = E(1 - e^{-t/\tau}) \quad ; \quad \tau = C \cdot R = 10\mu F \cdot 4\Omega = 40\mu s$$

$$\boxed{V_c(t) = 20V\,(1 - e^{-t/40\mu s})}$$

Luego, como $I(t) = \frac{dV_c(t)}{dt} \cdot C = \frac{20V}{40\mu s} e^{-t/40\mu s} \cdot 10\mu F$

$$\boxed{I(t) = 5A\, e^{-t/40\mu s}}$$

3 b)

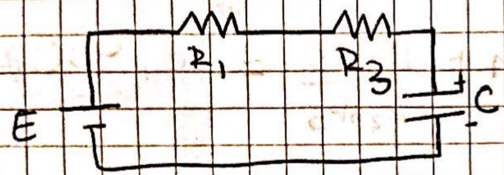


$R_1 = 10k\Omega$

R_2

$R_3 = 15k\Omega$

- cuando la llave está en 1:



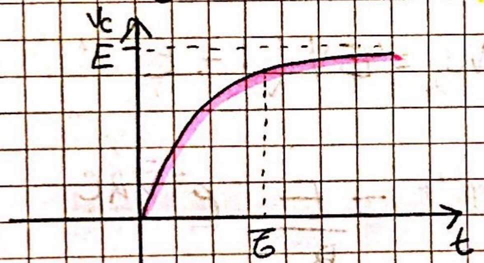
$$E = \frac{dQ}{dt} R_{eq} + \frac{Q}{C}$$

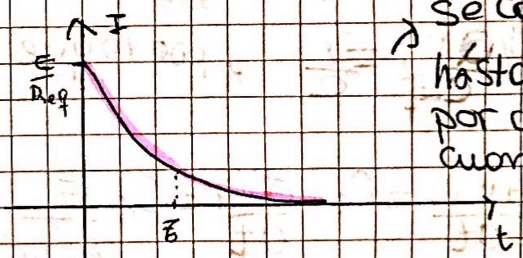
($Q(0) = 0$) C inicialmente descargado

$R_{eq} = R_1 + R_3$

$$\Rightarrow Q = CE\left[1 - e^{(-t/R_{eq} \cdot C)}\right]$$

$$\left[V_C = \frac{Q}{C} = E\left[1 - e^{-\frac{t}{R_{eq} C}}\right]\right] , \left[I = \frac{dQ}{dt} = \frac{E}{R_{eq}} \cdot e^{-t/R_{eq} \cdot C}\right]$$

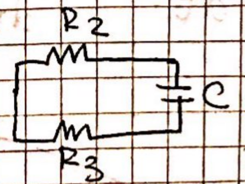




se carga C hasta cargarse por completo, cuando ya no circula I

$\tau = R_{eq} \cdot C = 25k\Omega \cdot C$

- Luego la llave pasa a 2:

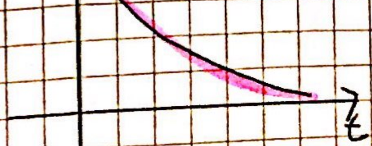


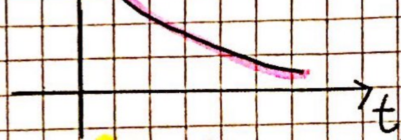
$R_{eq} = R_2 + R_3$

$Q(0) = E$ (capacitor inicialmente cargado)

$$\frac{Q}{C} = IR \quad , \quad I = \frac{dQ}{dt} \quad \Rightarrow Q = Q_0 \cdot e^{-t/R_{eq} \cdot C}$$

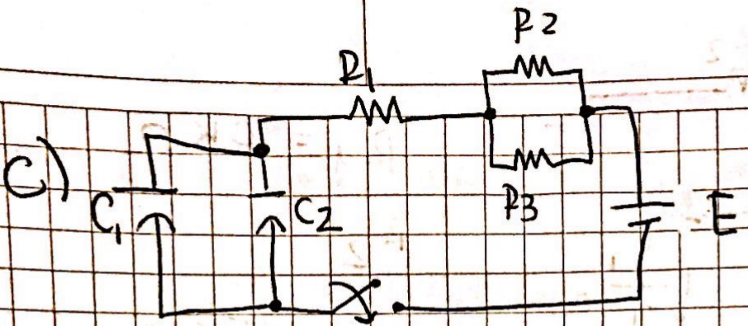
se descarga C





$$\left[V_C = \frac{Q_0}{C} \cdot e^{-t/R_{eq} \cdot C}\right] \quad \left[I = \frac{1}{R_{eq} C} \cdot Q_0 \cdot e^{-t/R_{eq} C}\right]$$

c)



$E = 45V$

$C_1 = 2,2\,\mu F$

$C_2 = 4,7\,\mu F$

$R_1 = 5,6\,k\Omega$

$R_2 = 47\,k\Omega$

$R_3 = 39\,k\Omega$

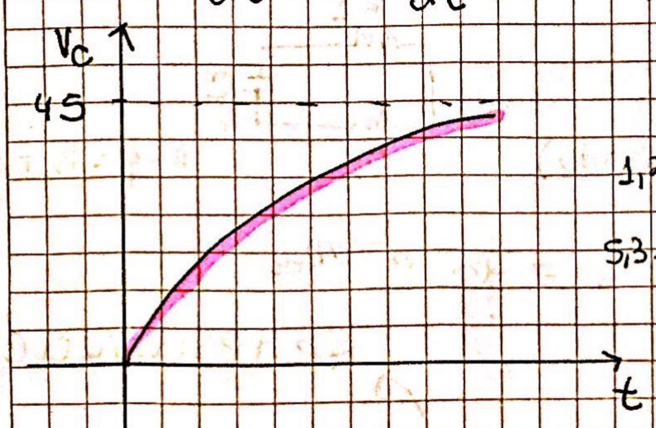
Simplificando el circuito:

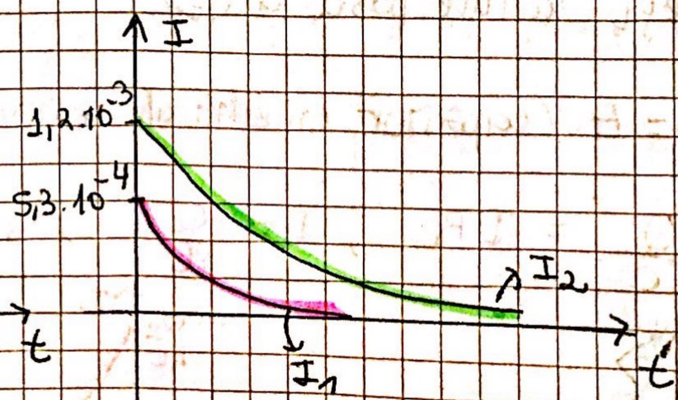
- $R_{eq} = R_1 + \dfrac{R_2 R_3}{R_2+R_3} = 26,9\,k\Omega$
- $C_{eq} = C_1 + C_2 = 6,9\,\mu F$
- $E = 45V$

Entonces: $E = \dfrac{dQ}{dt} \cdot R_{eq} + \dfrac{Q}{C_{eq}} \Rightarrow Q = C E \left[1 - e^{(-t/RC)}\right]$

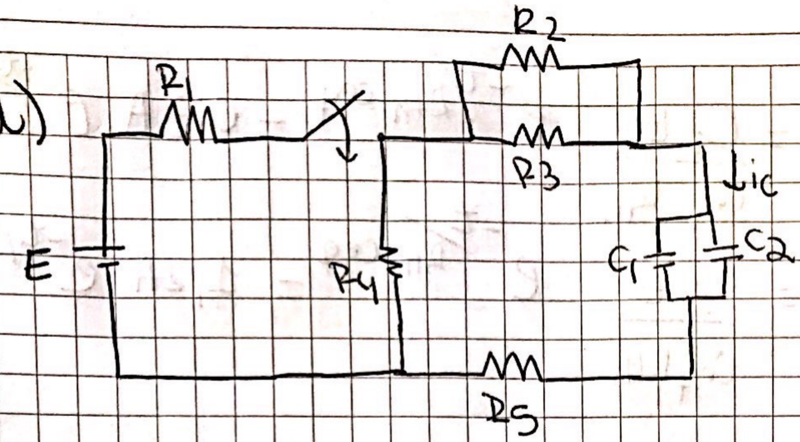
Además

- $V_{C_{eq}} = V_{C_1} = V_{C_2} = \dfrac{Q}{C}$, por lo que $V_{C_1} = V_{C_2} = 45V\left(1 - e^{-t/26,9k\Omega \cdot 6,9\mu}\right.$
- $I_{C_1} = \dfrac{dQ_1}{dt} = C_1 \cdot \dfrac{dV_{C_1}}{dt} = C_1 \cdot \dfrac{E}{R_{eq}C_{eq}} \cdot e^{-t/R_{eq}C_{eq}}$
- $I_{C_2} = \dfrac{dQ_2}{dt} = C_2 \dfrac{dV_{C_2}}{dt} = C_2 \dfrac{E}{R_{eq}C_{eq}} \cdot e^{-t/R_{eq}C_{eq}}$





d)



$E = 90V$ $R_1 = 30\Omega$

$R_2 = 80\Omega$ $R_3 = 20\Omega$

$R_4 = 60\Omega$ $R_5 = 4\Omega$

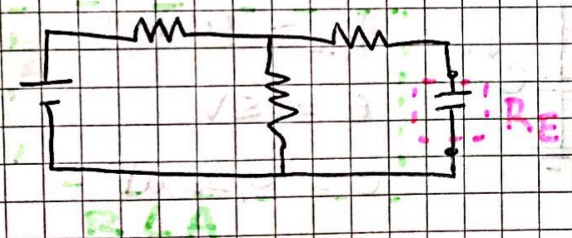
$C_1 = 10\mu F$ $C_2 = 40\mu F$

Primero simplifico el circuito:

$$R_{eq} = \frac{R_2 R_3}{R_2+R_3} + R_5 = 20\Omega$$

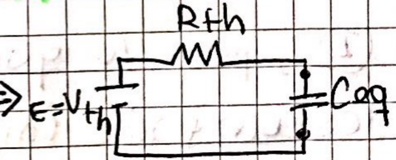
$$C_{eq} = C_1 + C_2 = 50\mu F$$

Ahora puedo aplicar thévenin:



$$\cdot R_{th} = \frac{R_1 R_4}{R_1+R_4} + R_{eq} = 40\Omega$$

$$\cdot V_{th} = 60\Omega \cdot \frac{90V}{3\Omega+60\Omega} = 60V$$



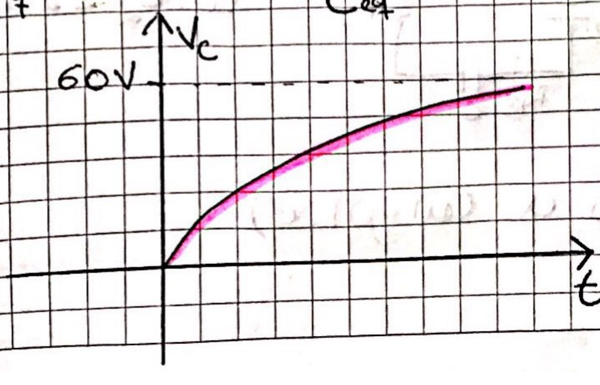
Donde

$$\cdot E = IR + \frac{Q}{C} = \frac{dQ}{dt} R_{th} + \frac{Q}{C_{eq}}$$

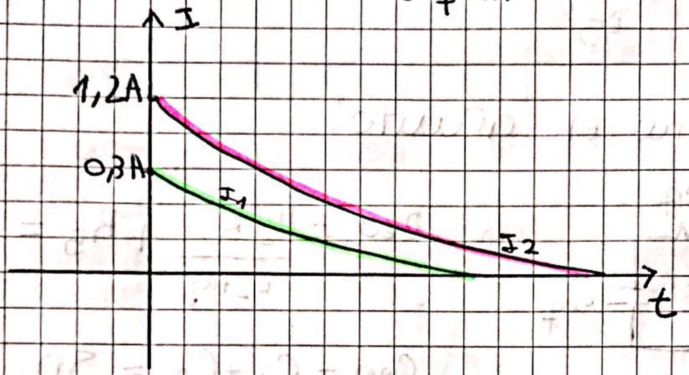
$$\Rightarrow Q = E \cdot C_{eq}\left(1 - e^{\frac{-t}{R_{th} C_{eq}}}\right)$$

Entonces:

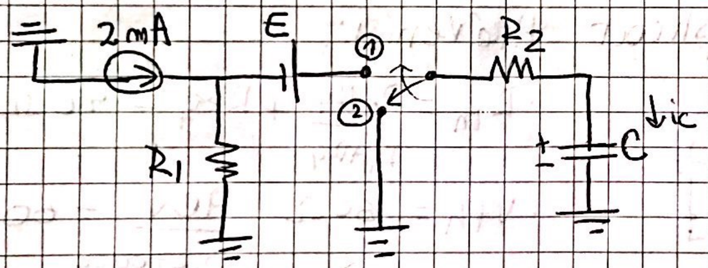
$$\bullet V_{C_{eq}} = V_{C_1} = V_{C_2} = \frac{Q}{C_{eq}} = E\left(1 - e^{\frac{-t}{R_{th} \cdot C_{eq}}}\right) = 60V\left(1 - e^{\frac{-t}{40\Omega \cdot 50\mu F}}\right)$$



- $I_{C1} = \frac{dQ}{dt} = C_1 \cdot \frac{dV}{dt} = \frac{C_1 E}{C_{eq} \cdot R_{th}} \cdot e^{-t/R_{th} C_{eq}} = 0{,}3A \cdot e^{-t/2\,ms}$
- $I_{C2} = \frac{dQ}{dt} = C_2 \frac{dV}{dt} = \frac{C_2 E}{C_{eq} R_{th}} \cdot e^{-t/R_{th} C_{eq}} = 1{,}2A \cdot e^{-t/2ms}$

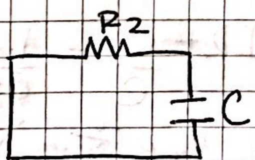


e)

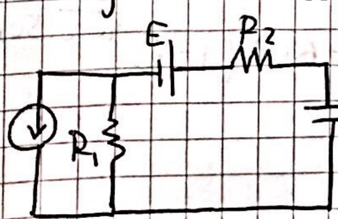


$R_1 = 15K\Omega$
$R_2 = 10K\Omega$
$E = 5V$
$C = 0{,}22\mu F$

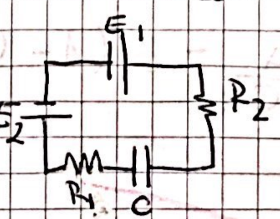
Primero la llave está en ②, por lo que C está descargado inicialmente



Luego se coloca la llave en ①:



≡



con $E_2 = 2mA \cdot R_1$

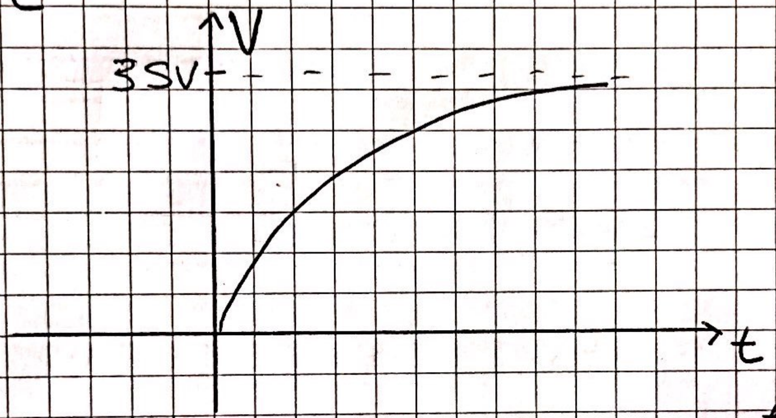
(El capacitor comienza a cargarse)

Donde $E = \frac{Q}{C} + \frac{dQ}{dt} R$

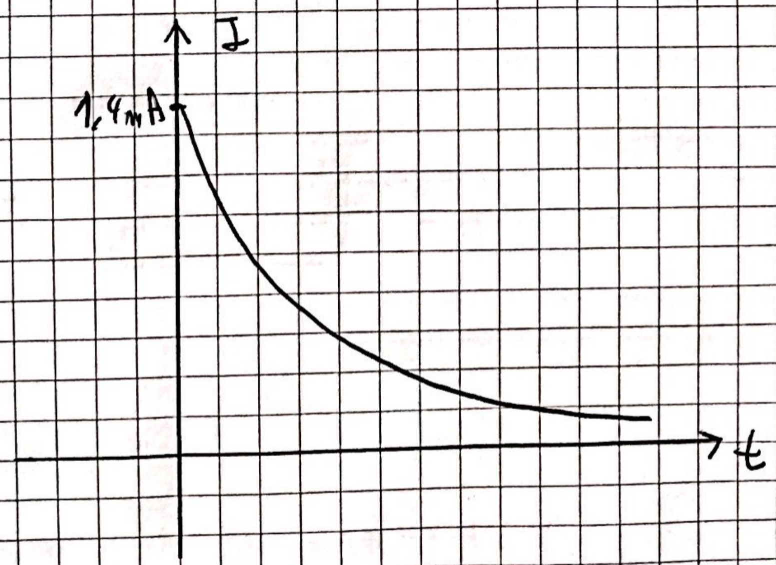
$$\Rightarrow Q = C E \cdot \left(1 - e^{-t/RC}\right)$$

Entonces

- $V_C = \frac{Q}{C} = E\left(1 - e^{-t/RC}\right) = (5V + 30V)\left(1 - e^{-\frac{t}{25k\Omega \cdot 0{,}22\mu F}}\right)$



- $I_C = \frac{dQ}{dt} = \frac{E}{R} \cdot e^{-t/RC} = \frac{35V}{25k\Omega} \cdot e^{-t/25k\Omega \cdot 0{,}22\mu F}$



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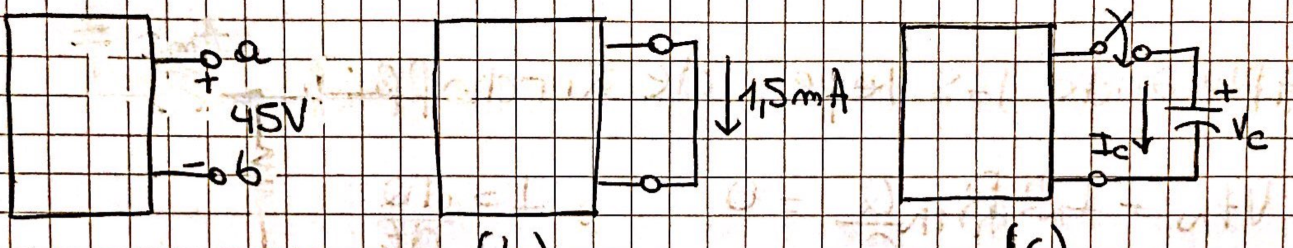
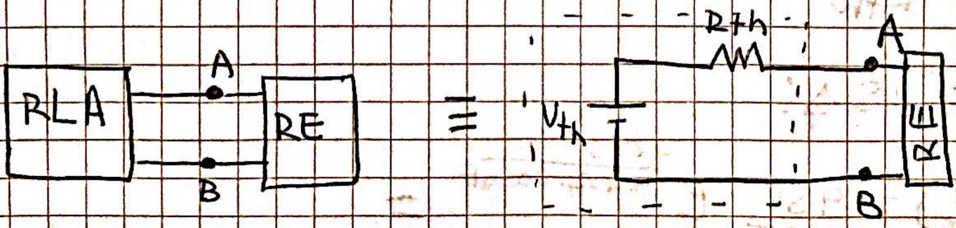
(4) Una caja negra contiene resistores y fuentes. Se la mide externamente y se obtienen los valores indicados. Luego se le conecta un capacitor de 500 uF mediante una llave. Determinar el valor de la corriente en el capacitor 25 s después de conectar la llave.

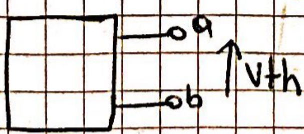


(a) (b) (c)

Usando el teorema de thévenin, podemos pensar a la caja como la red lineal activa



Entonces por (a) $V_{th} = 45V$.

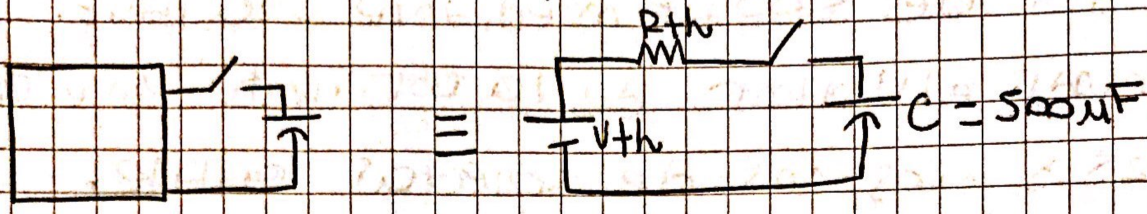


Análogamente, usando el teorema de Norton, por (b)

$I_N = 1,5 \, mA$

Además $R_{th} = \frac{V_{th}}{I_N} = \frac{45V}{1,5mA} = 30k\Omega$

Entonces (c) es equivalente a:



Aplicando las leyes de Kirchoff:

$$V_{th} - IR_{th} - \frac{Q}{C} = 0 \quad , \quad I = \frac{dQ}{dt}$$

$$\Rightarrow Q = C.V_{th}\left[1 - e^{(-t/R_{th}.C)}\right]$$

$$\Rightarrow \left[I = \frac{V_{th}}{R_{th}} e^{-t/R_{th}.C}\right]$$

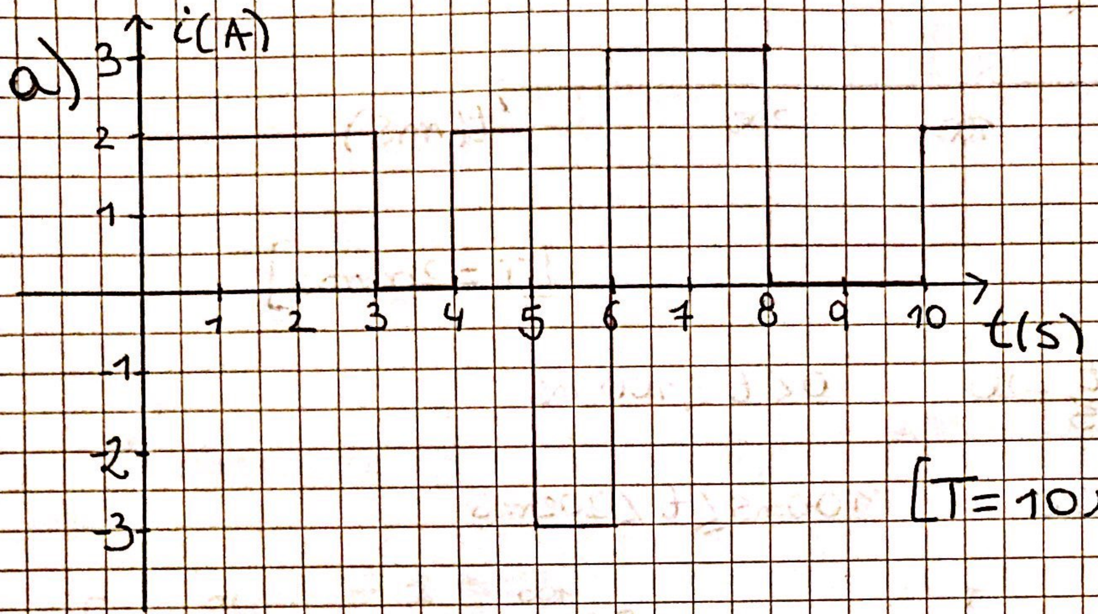
Para $t = 25s$:

$$I(25s = t) = \frac{45V}{30k\Omega} . e^{-\frac{25s}{30k\Omega . 500\mu F}}$$

$$\left[I(25s) = 0,283\ mA\right]$$

(5) Determine los valores medio y eficaz de cada una de las formas de onda

a)



$[T = 10s]$

Sabiendo que $I_{Medio} = \frac{1}{T} \cdot \int_0^T I\,dt$ y teniendo la función partida $I(t)$:

$$I_{Medio} = \frac{1}{10} \cdot \left[\int_0^3 2dt + \int_3^4 0 \cdot dt + \int_4^5 2\,dt + \int_5^6 (-3)dt + \int_6^8 3dt + \int_8^{10} 0dt \right]$$

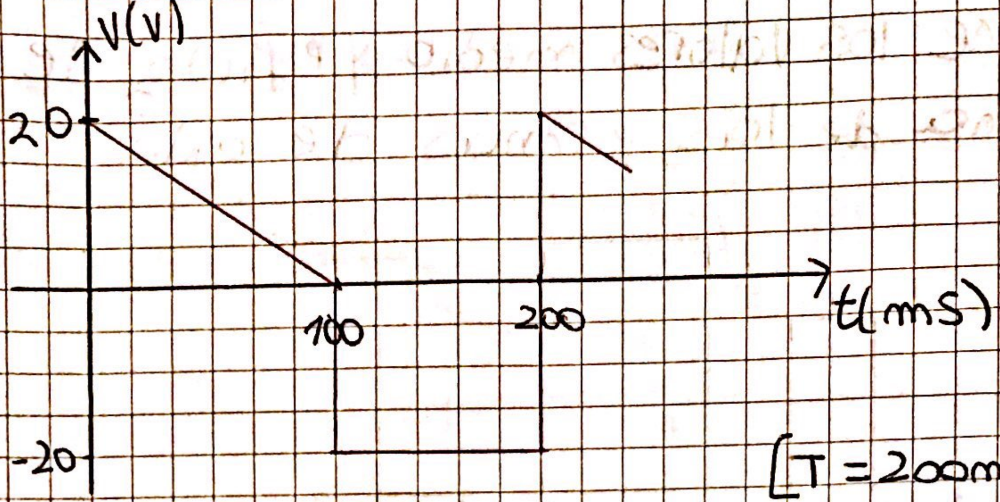
$$\Rightarrow \boxed{I_{Medio} = \frac{1}{10} \cdot 11A = 1{,}1A}$$

Por otro lado $I_{ef} = \sqrt{\frac{1}{T} \cdot \int_0^T I^2 dt}$, entonces:

$$I_{ef} = \sqrt{\frac{1}{10} \cdot \int_0^{10} I^2 dt} = \sqrt{\frac{1}{10} \cdot \left(\int_0^3 2^2 dt + \int_4^5 2^2 dt + \int_5^6 (-3)^2 dt + \int_6^8 3^2 dt \right)}$$

$$\Rightarrow \boxed{I_{ef} = \sqrt{\frac{43}{10}} \simeq 2{,}074A}$$

b)



[T = 200ms]

$$V(t) = \begin{cases} -\frac{t}{5} + 20 & 0 < t < 100\text{ ms} \\ -20 & 100\text{ms} \leq t < 200\text{ms} \end{cases}$$

$$\cdot V_{Medio} = \frac{1}{T}\int_0^T v(t)\,dt = \frac{1}{200}\left[\int_0^{100}\left(-\frac{t}{5}+20\right)dt + \int_{100}^{200}(-20)\,dt\right]$$

$$\left[V_{Medio} = \frac{1}{200}\cdot(-1000) = -5V\right]$$

$$\cdot V_{ef} = \sqrt{\frac{1}{T}\int_0^T V^2\,dt} = \sqrt{\frac{1}{200}\left(\int_0^{100}\left(-\frac{t}{5}+20\right)^2 dt + \int_{100}^{200}(-20)^2\,dt\right)}$$

$$\left[V_{ef} = \sqrt{\frac{1}{200}\cdot\frac{160000}{3}} \simeq 16{,}33V\right]$$

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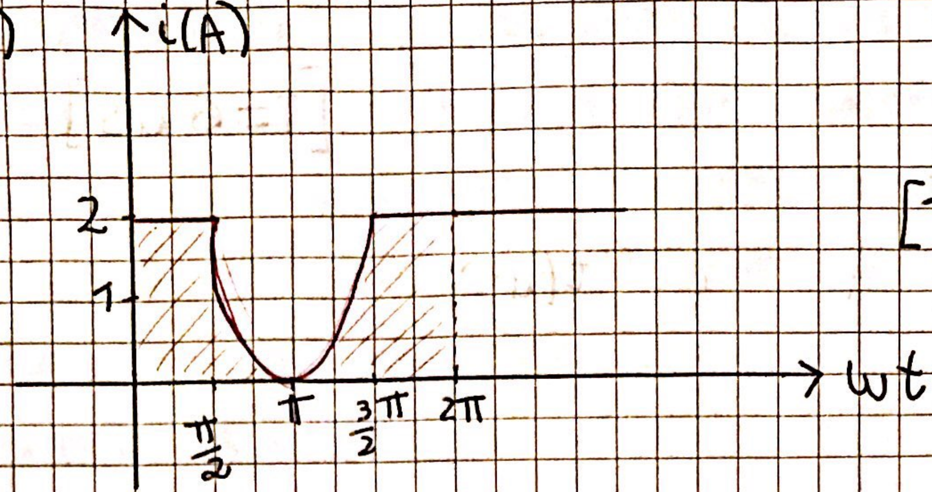
c)



[T=2π]

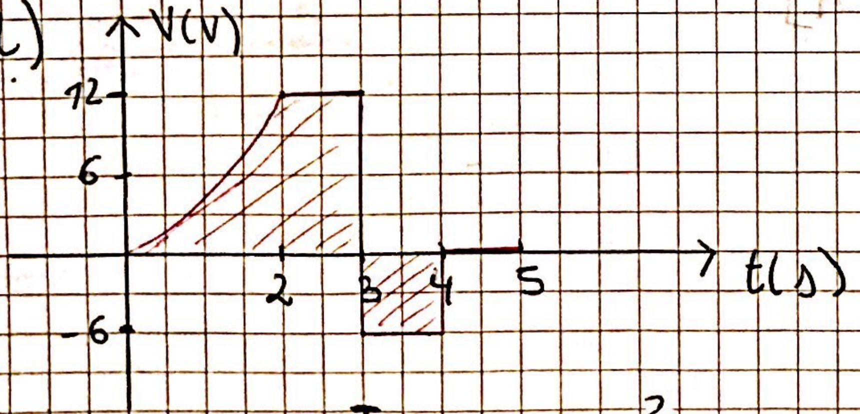
• $I_{Medio} = \frac{1}{T}\int_0^T I\,dt = \frac{1}{2\pi}\cdot\left[\int_0^{\frac{\pi}{2}} 2\,dt + \int_{\frac{\pi}{2}}^{3/2\pi}(2\cos(t)+2)\,dt + \int_{\frac{3}{2}\pi}^{2\pi} 2\,dt\right]$

[$I_{Medio} \simeq 1{,}36\,A$]

• $I_{ef} = \sqrt{\frac{1}{T}\int_0^T I^2\,dt} = \sqrt{\frac{1}{2\pi}\left(2\int_0^{\frac{\pi}{2}} 2^2\,dt + \int_{\frac{\pi}{2}}^{3/2\pi}(2\cos(t)+2)^2\,dt\right)}$

[$I_{ef} \simeq 1{,}57\,A$]

d)



[T=4 s]

$$V(t) = \begin{cases} 3t^2 & 0<t<2 \\ 12 & 2<t<3 \\ -6 & 3<t<4 \end{cases}$$

• $V_{Medio} = \frac{1}{T}\int_0^T V\,dt = \frac{1}{4}\left(\int_0^2 3t^2\,dt + \int_3^4(-6)\,dt + \int_2^3 12\,dt\right)$

[$V_{Medio} = 3{,}5\ V$]

• $V_{ef} = \sqrt{\frac{1}{T}\cdot\left(\int_0^T V^2\,dt\right)} = \sqrt{\frac{1}{4}\left(\int_0^2 (3t^2)^2\,dt + \int_3^4 (-6)^2\,dt + \int_2^3 12^2\,dt\right)}$

[$V_{ef} \simeq 7{,}7\,V$]

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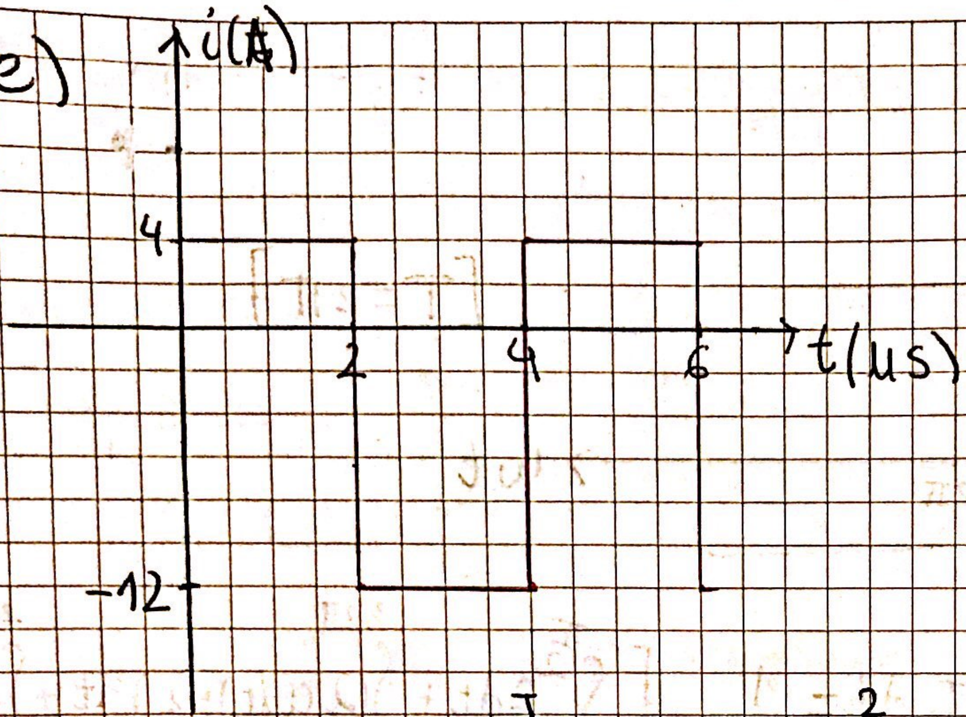
e)



$[T = 6\,\mu s]$

- $I_{Medio} = \frac{1}{T} \int_0^T I\,dt = \frac{1}{6} \left(\int_0^2 4\,dt + \int_2^4 (-12)\,dt + \int_4^6 4\,dt \right)$

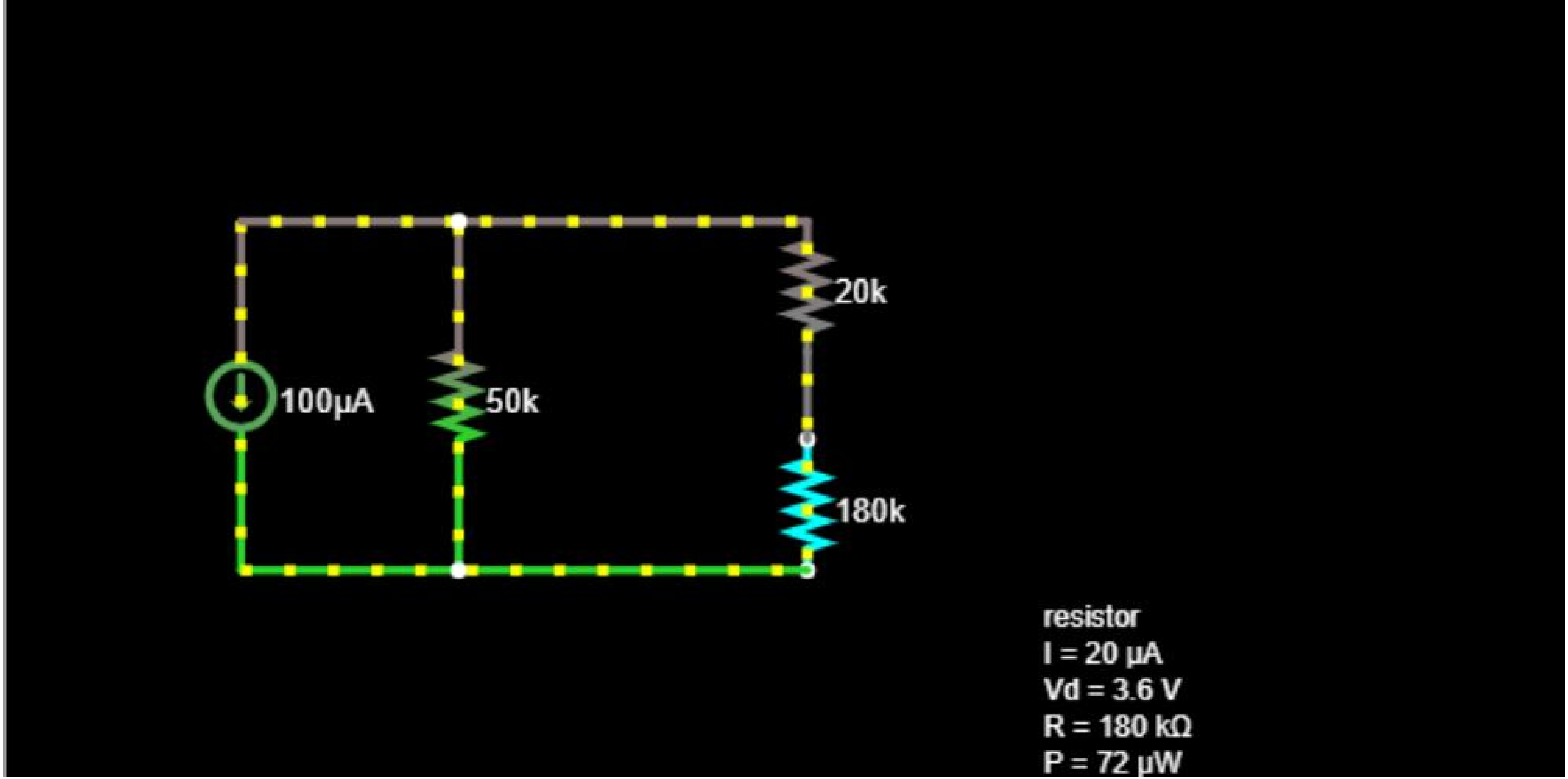
  $[I_{Medio} \cong -1{,}33\,A]$

- $I_{ef} = \sqrt{\frac{1}{T} \cdot \int_0^T I^2\,dt} = \sqrt{\frac{1}{6} \left(\int_0^2 4^2\,dt + \int_2^4 (-12)^2\,dt + \int_4^6 4^2\,dt \right)}$

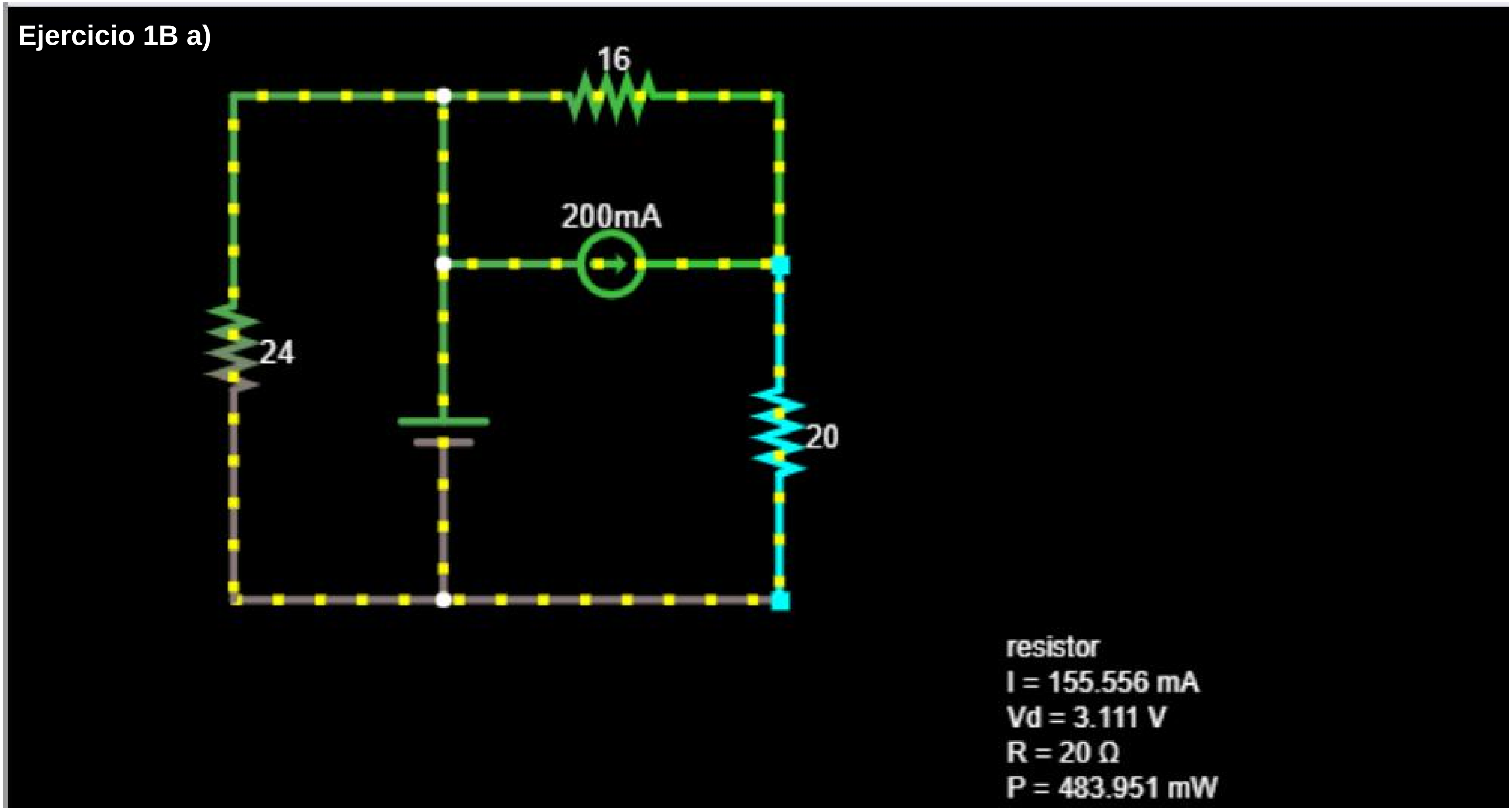
  $[I_{ef} \cong 7{,}66\,A]$

Anexo: SIMULACIONES

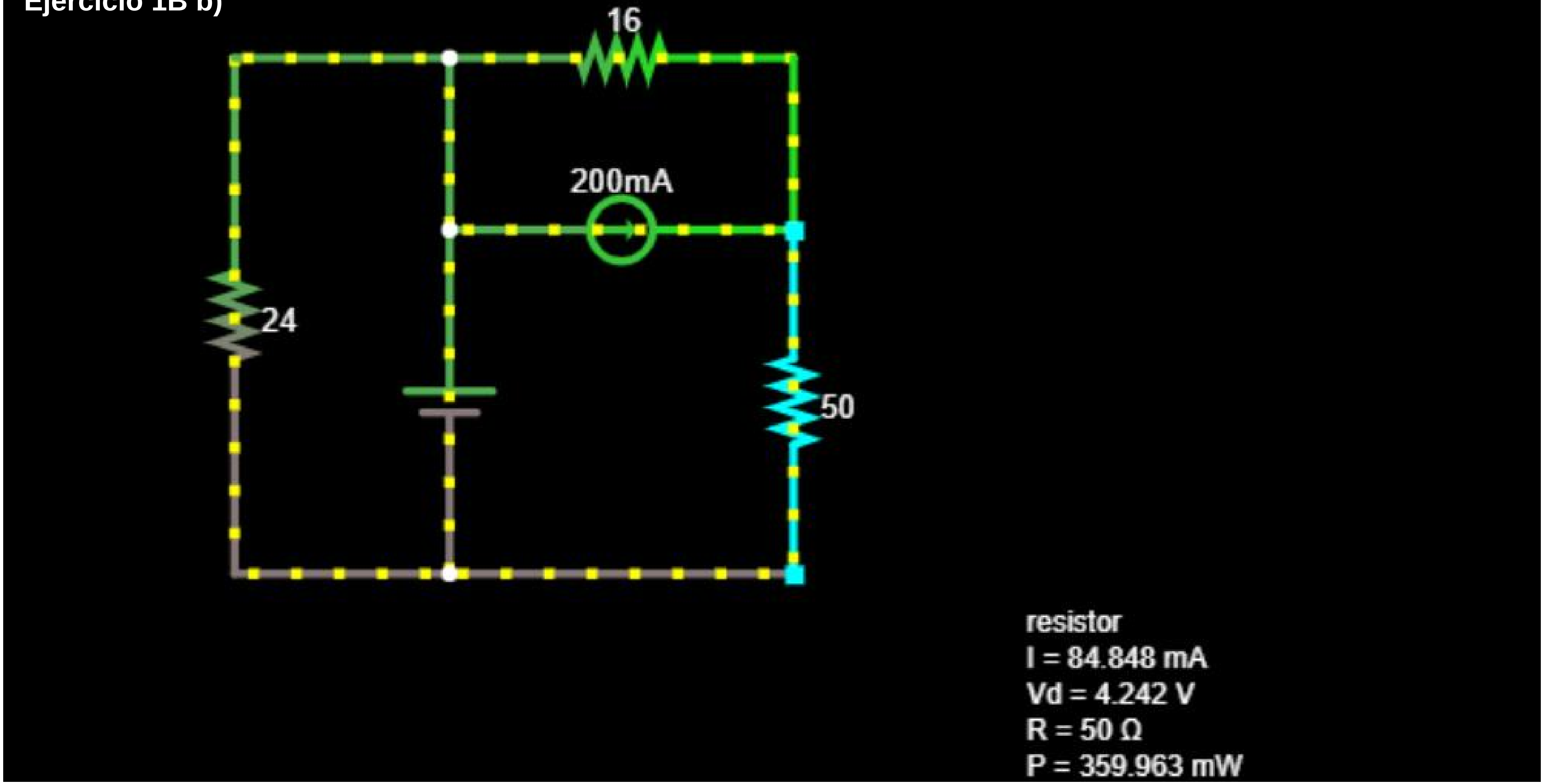
Ejercicio 1A



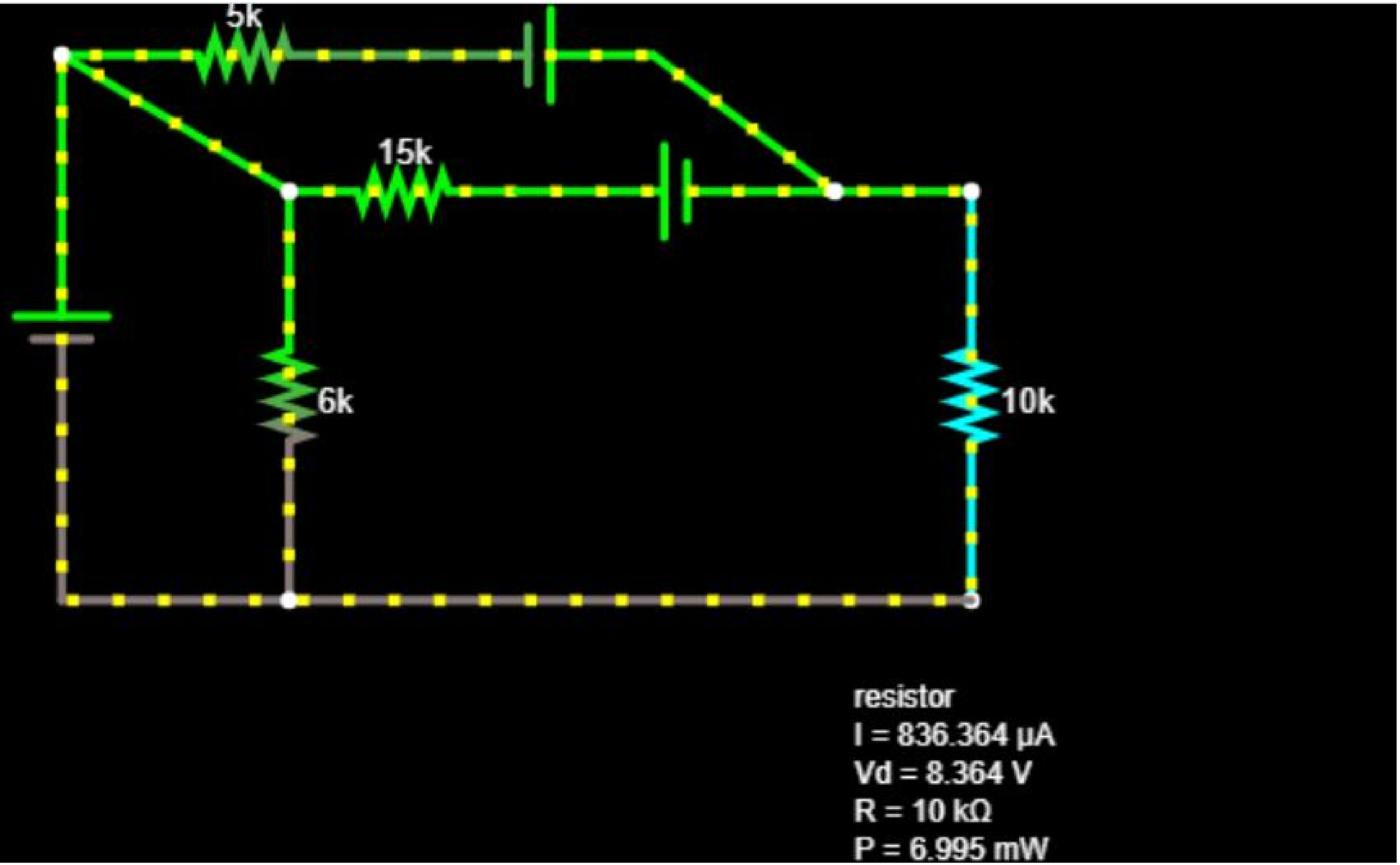
Ejercicio 1B a)



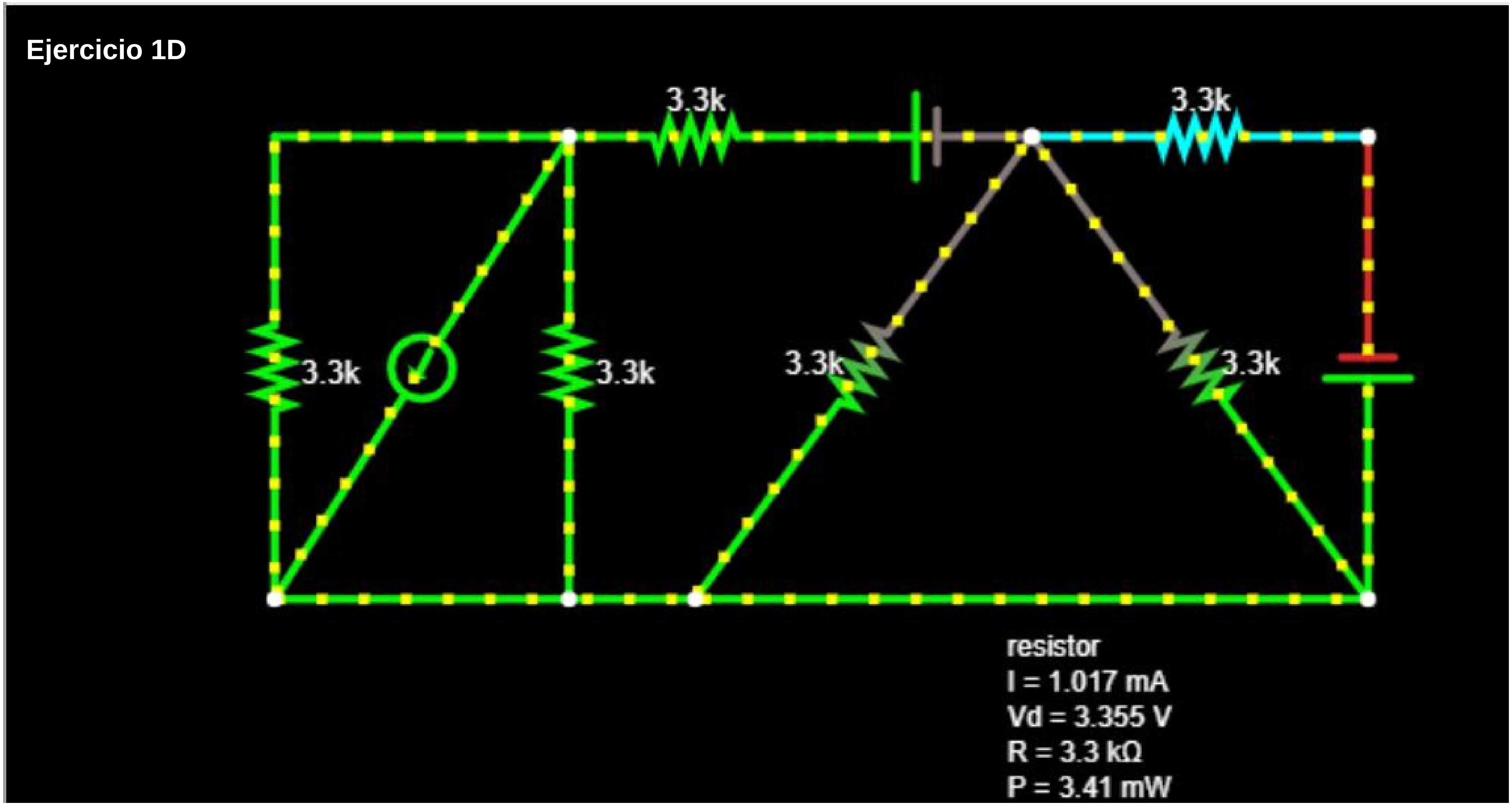
Ejercicio 1B b)



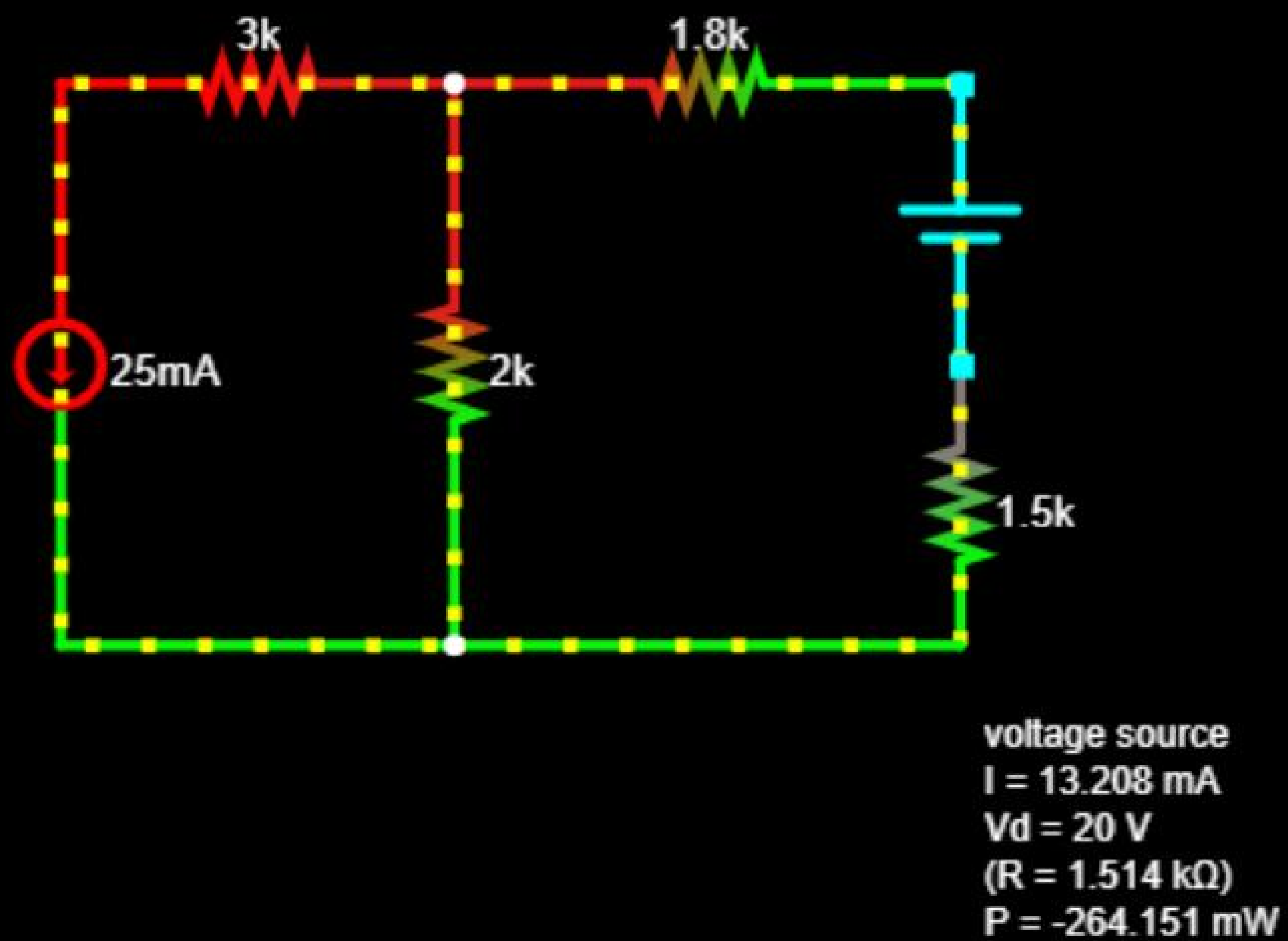
Ejercicio 1C a)

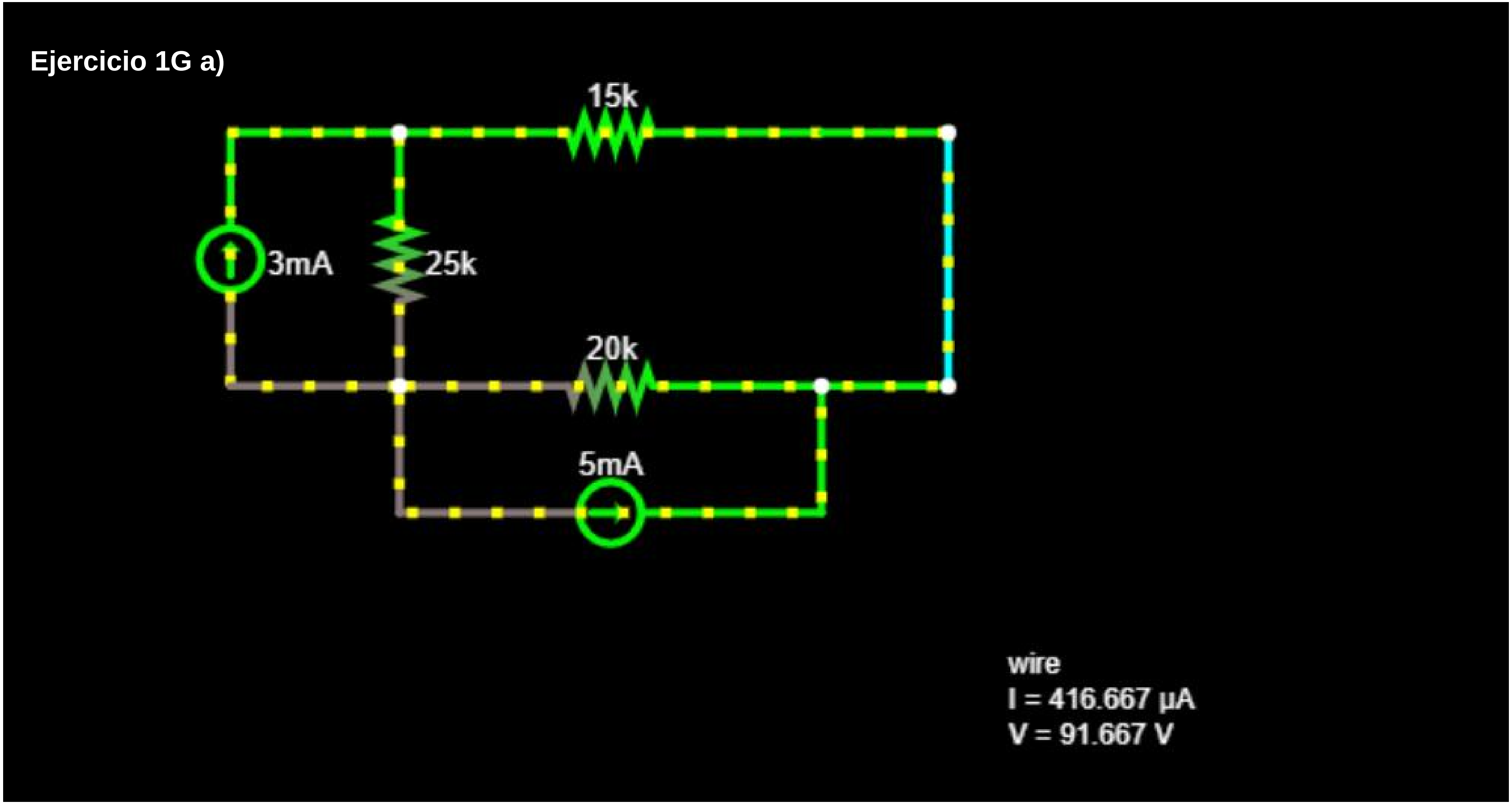


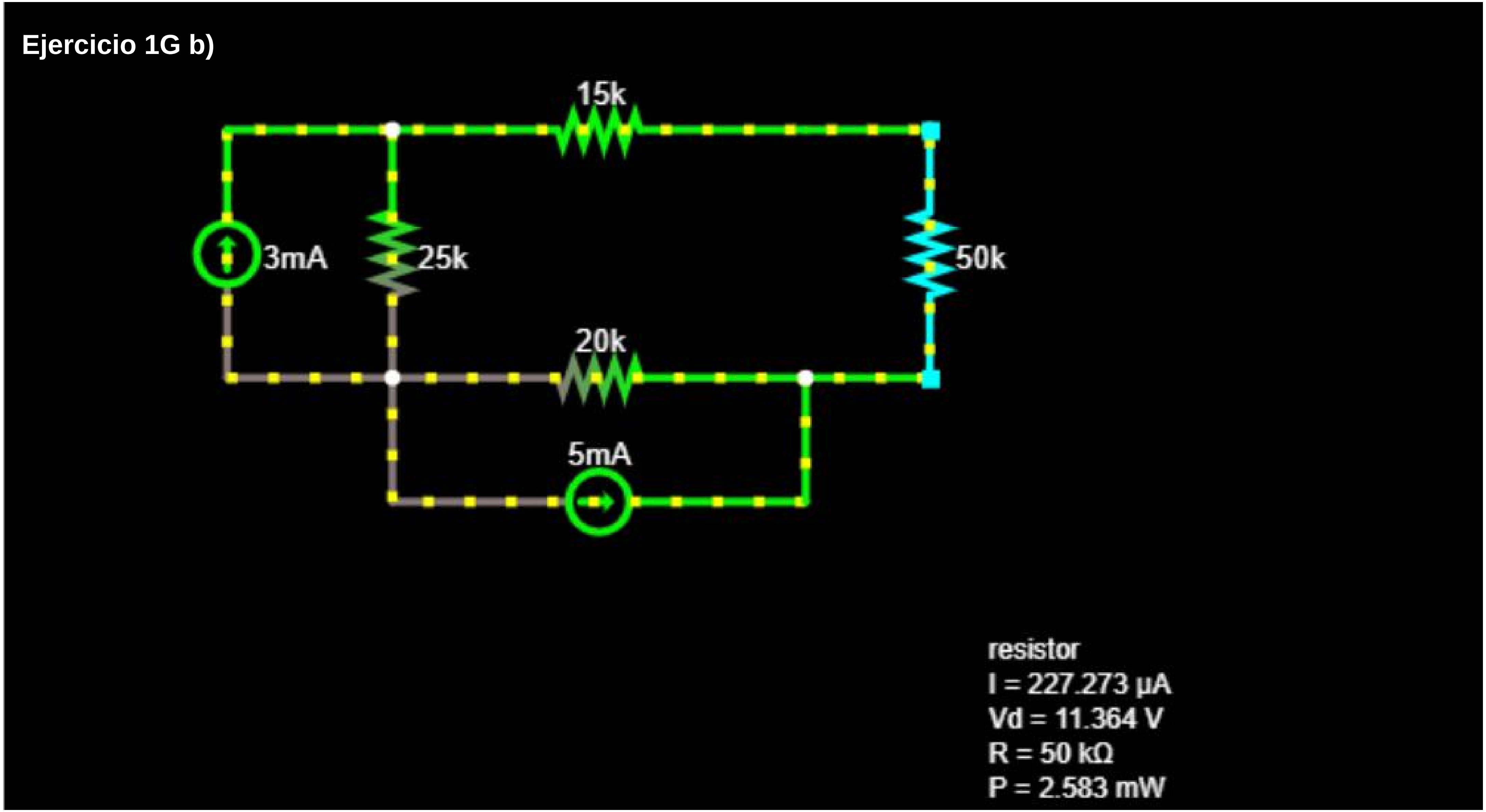

Ejercicio 1C b)
5k
15k
6k
20k
resistor
I = 484.211 μA
Vd = 9.684 V
R = 20 kΩ
P = 4.689 mW


Ejercicio 1D
3.3k
3.3k
3.3k
3.3k
3.3k
3.3k
resistor
I = 1.017 mA
Vd = 3.355 V
R = 3.3 kΩ
P = 3.41 mW

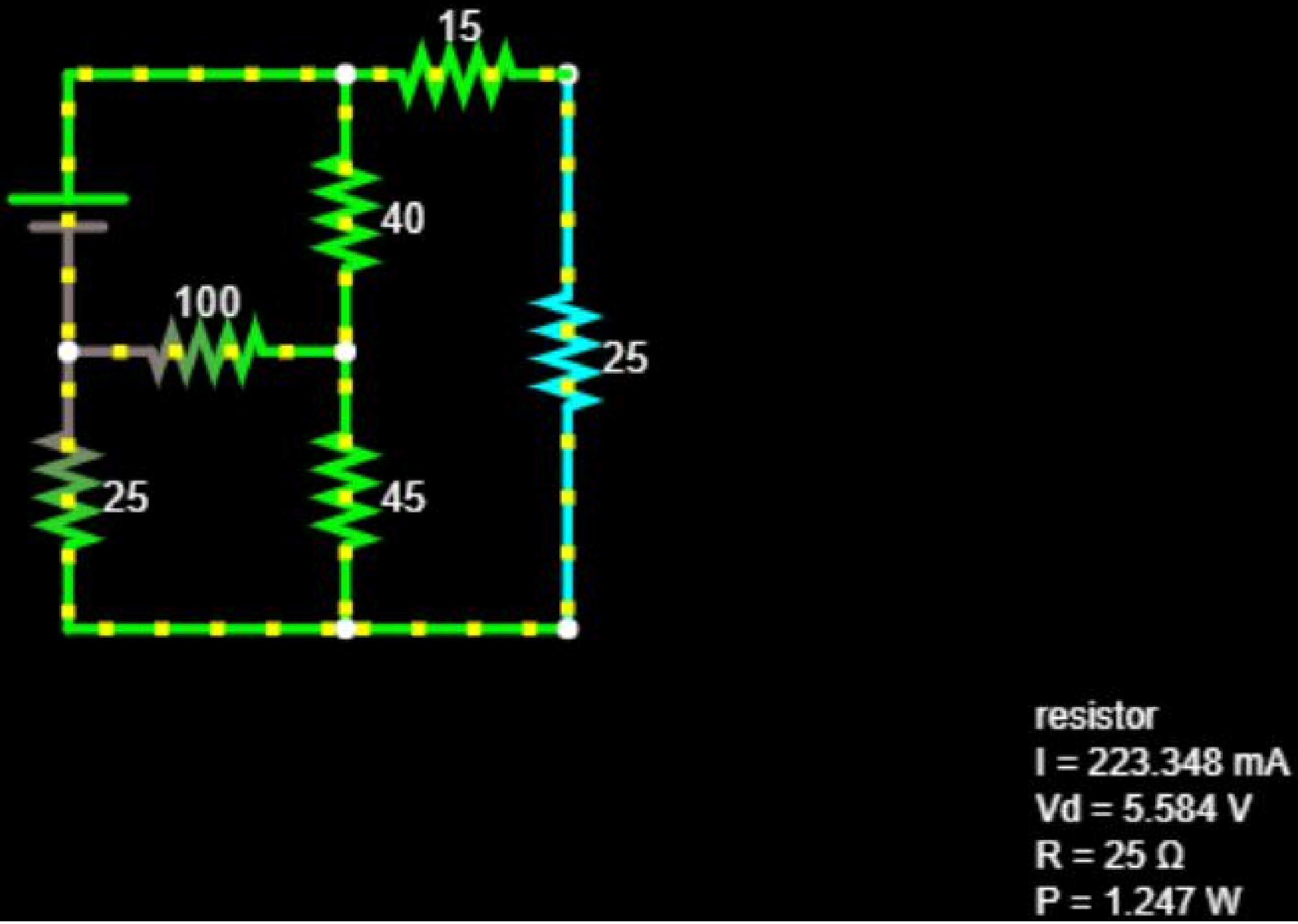
Ejercicio 1E

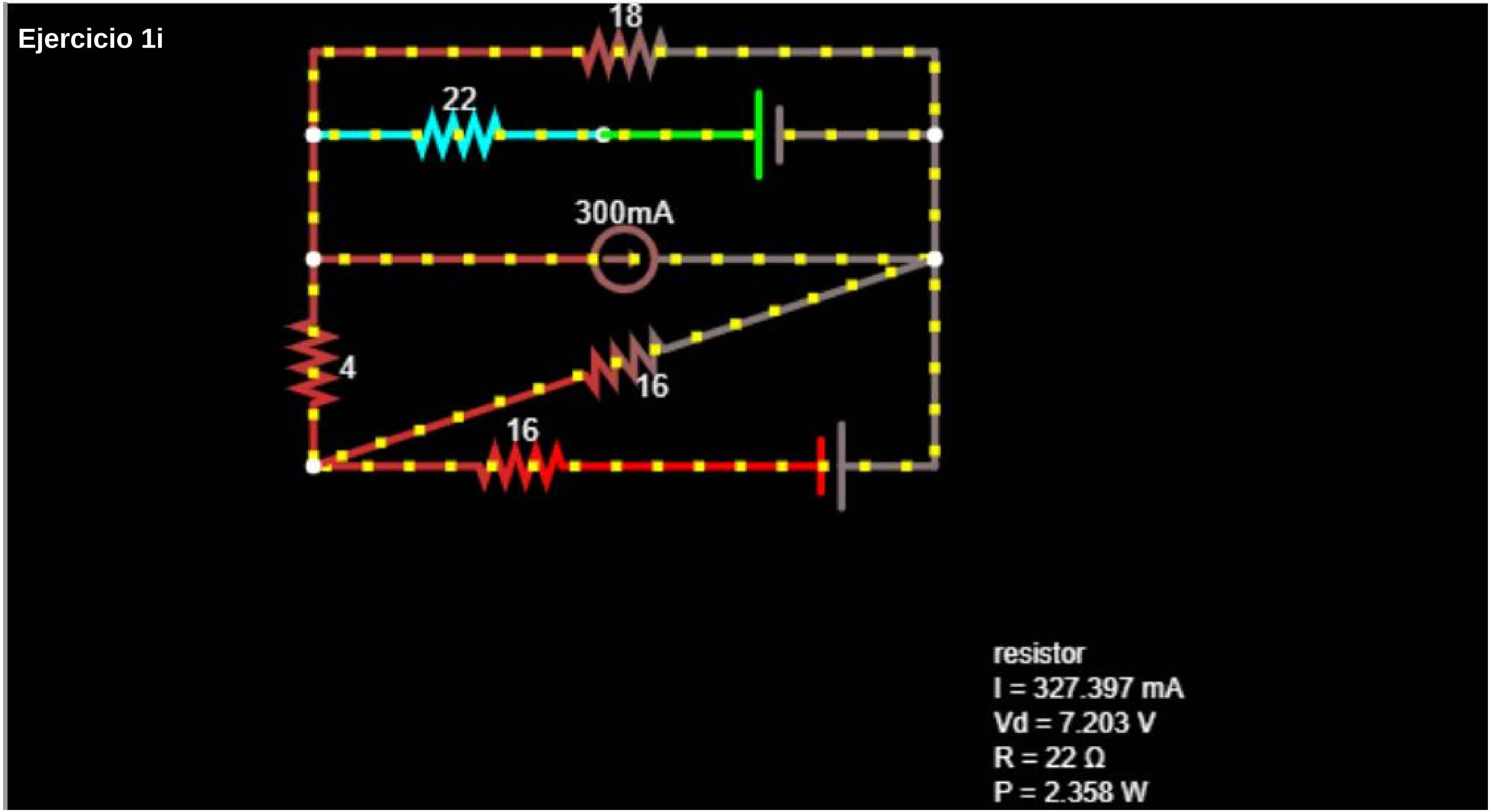


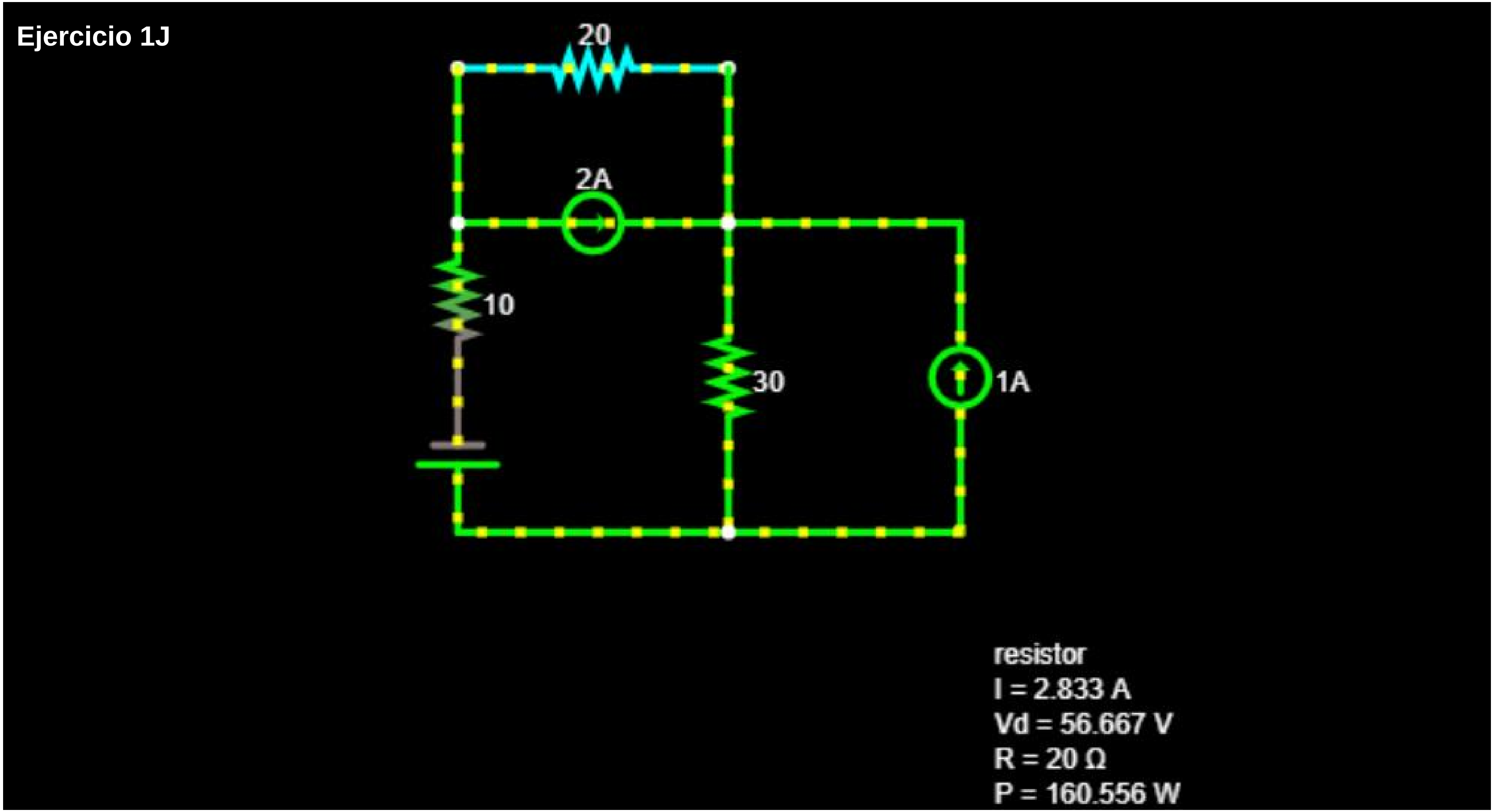

Ejercicio 1G a)
15k
3mA
25k
20k
5mA
wire
I = 416.667 µA
V = 91.667 V


Ejercicio 1G b)
15k
3mA
25k
50k
20k
5mA
resistor
I = 227.273 µA
Vd = 11.364 V
R = 50 kΩ
P = 2.583 mW

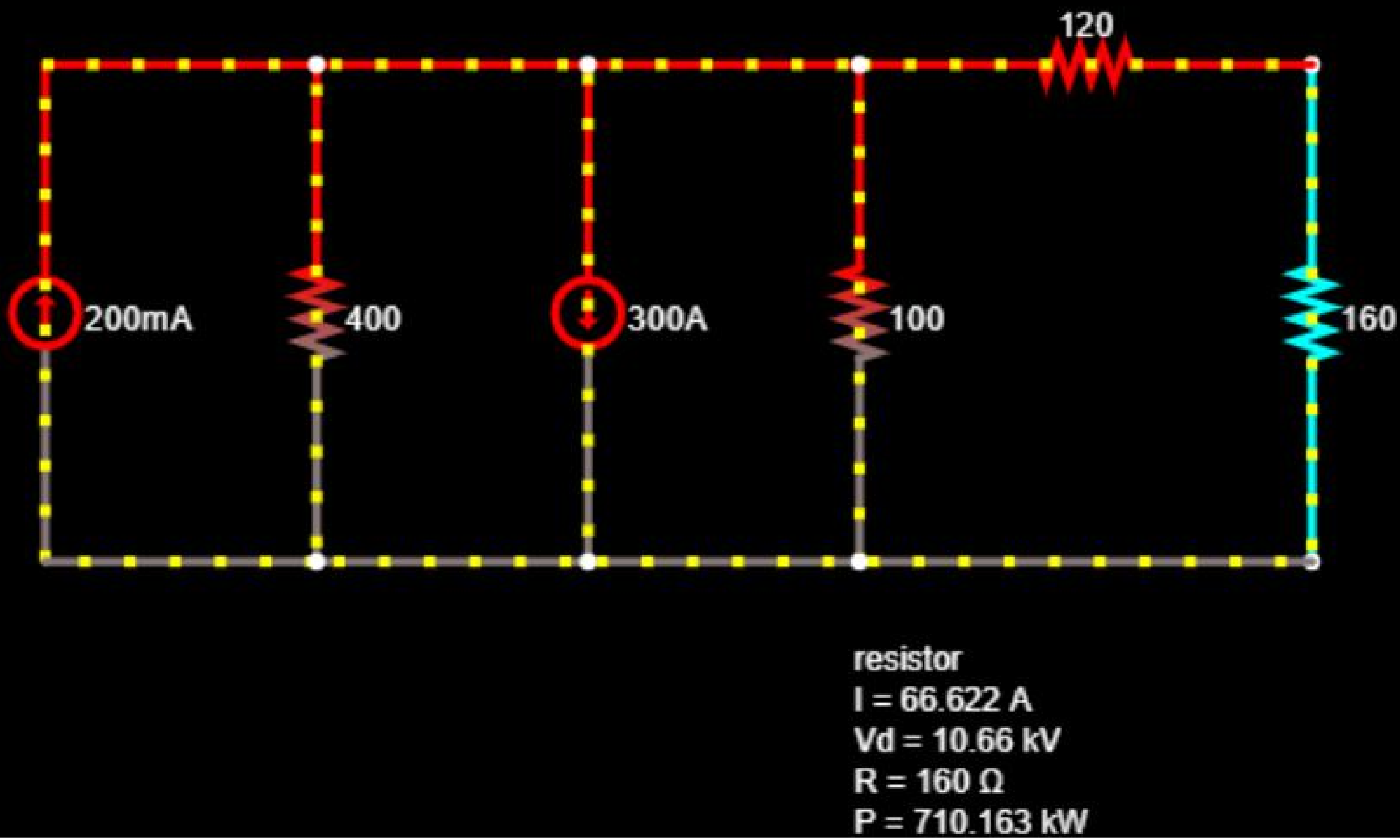
Ejercicio 1H

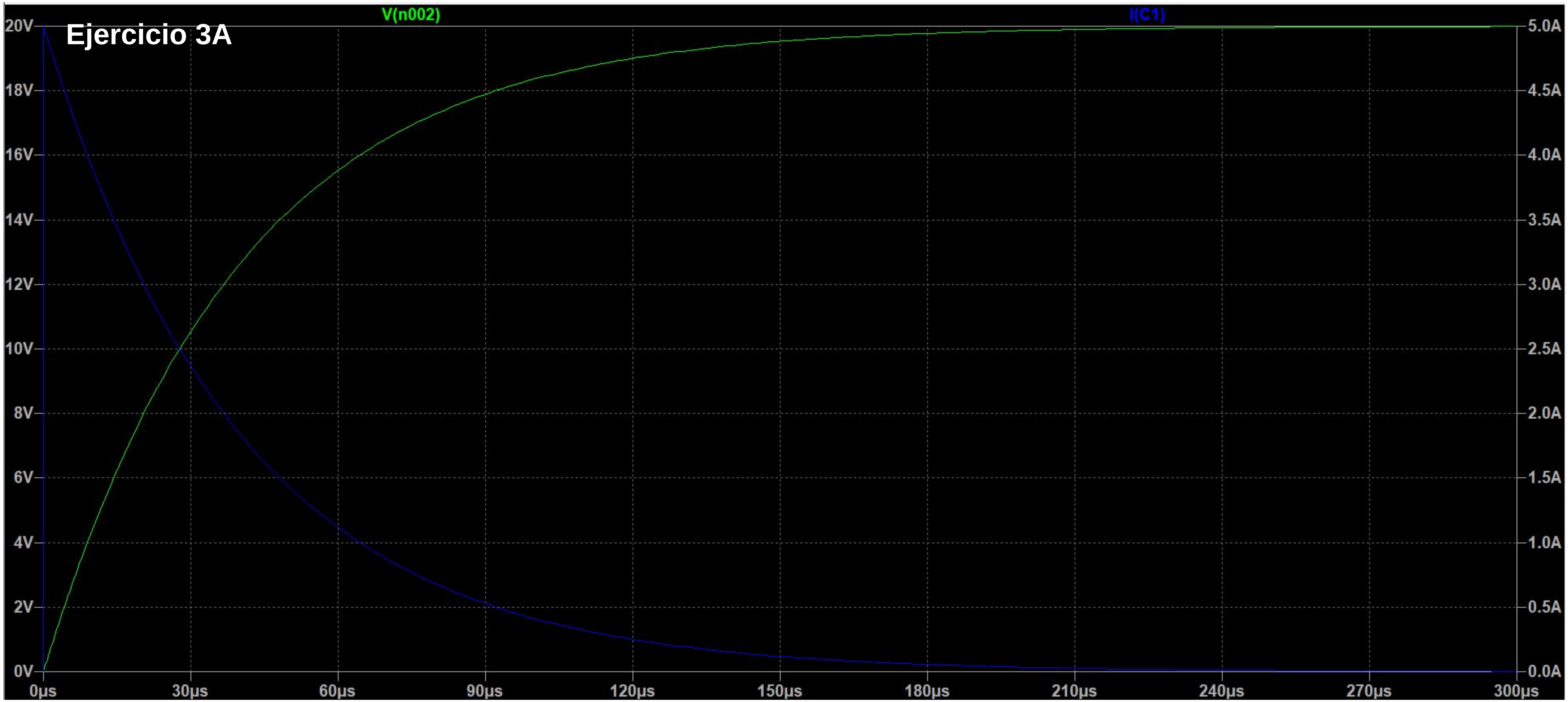



Ejercicio 1i
18
22
300mA
4
16
16
resistor
I = 327.397 mA
Vd = 7.203 V
R = 22 Ω
P = 2.358 W


Ejercicio 1J
20
2A
10
30
1A
resistor
I = 2.833 A
Vd = 56.667 V
R = 20 Ω
P = 160.556 W

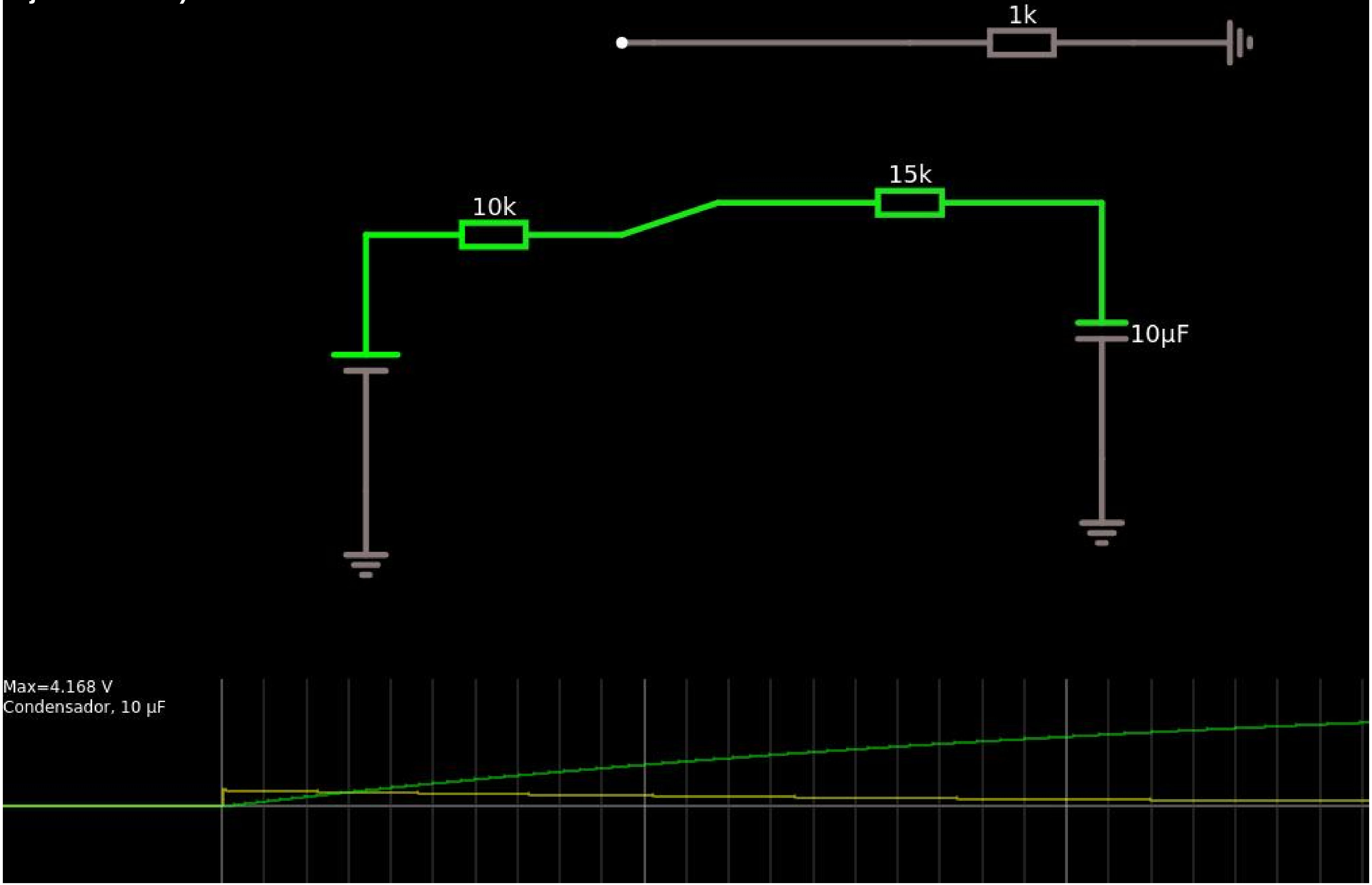
Ejercicio 1K



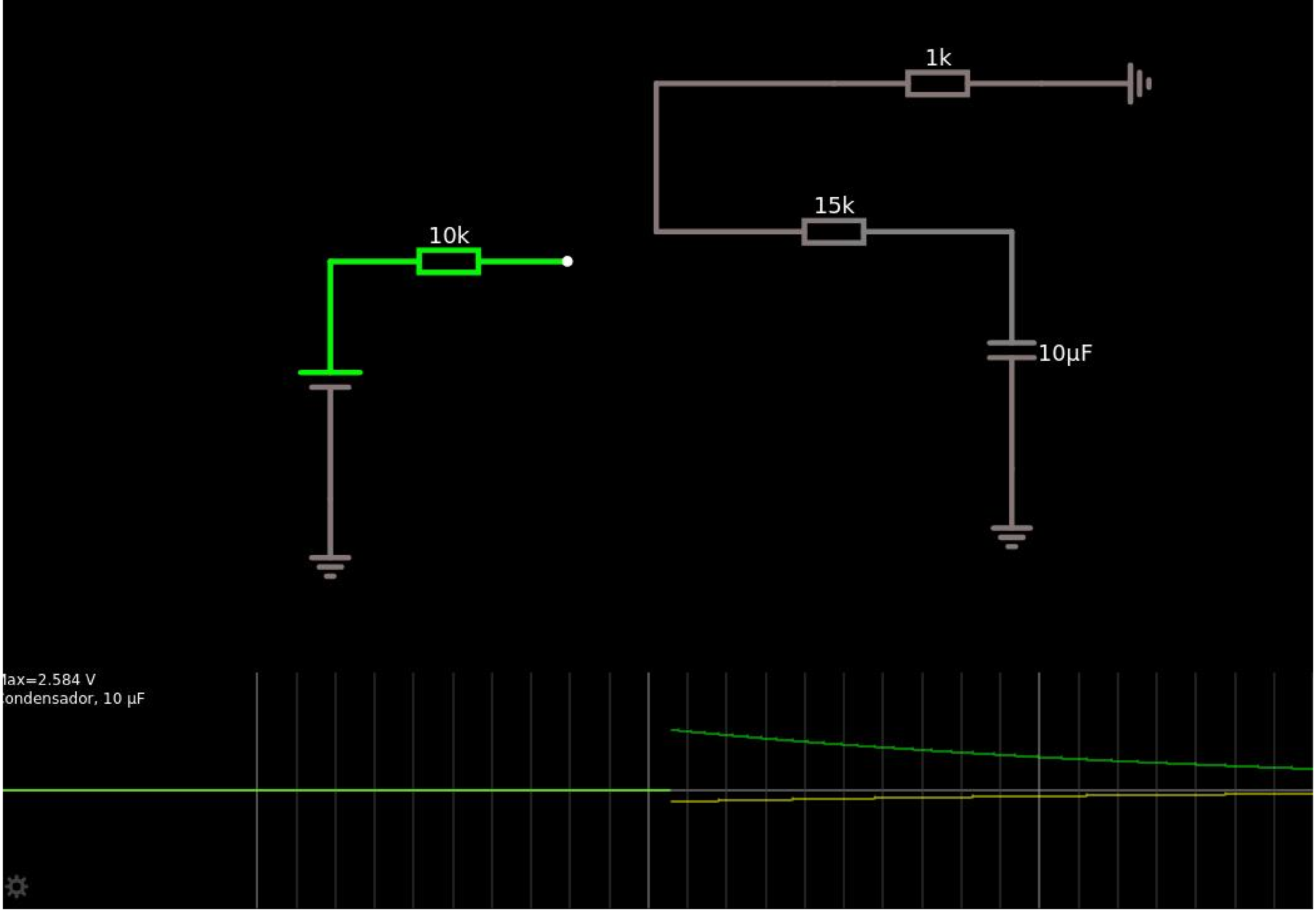


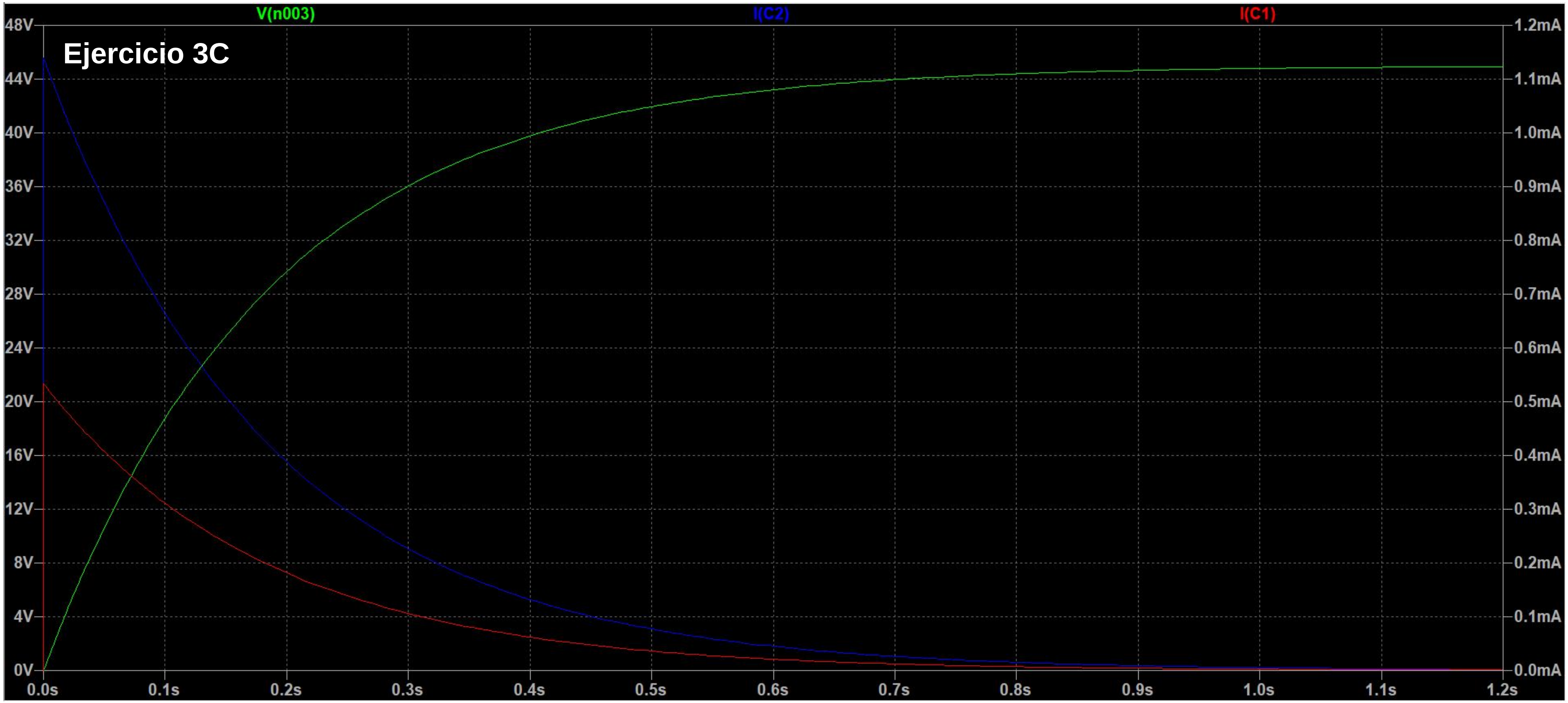
Ejercicio 3A
V(n002)
I(C1)
20V
18V
16V
14V
12V
10V
8V
6V
4V
2V
0V
5.0A
4.5A
4.0A
3.5A
3.0A
2.5A
2.0A
1.5A
1.0A
0.5A
0.0A
0µs
30µs
60µs
90µs
120µs
150µs
180µs
210µs
240µs
270µs
300µs

Ejercicio 3B a)



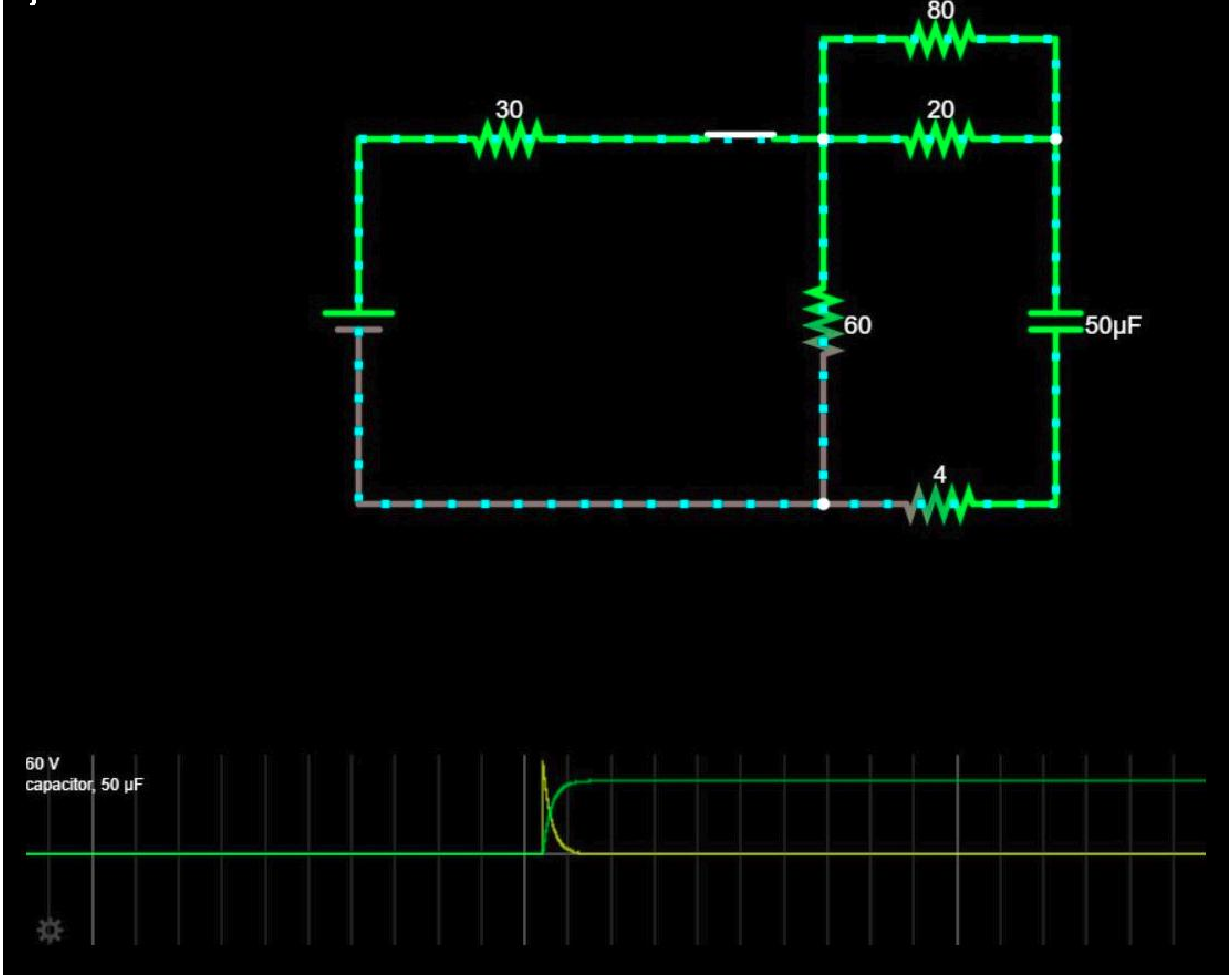
Ejercicio 3B b)





Ejercicio 3C
V(n003)
I(C2)
I(C1)
48V
44V
40V
36V
32V
28V
24V
20V
16V
12V
8V
4V
0V
1.2mA
1.1mA
1.0mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0.0mA
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
1.1s
1.2s

Ejercicio 3D



Ejercicio 3E