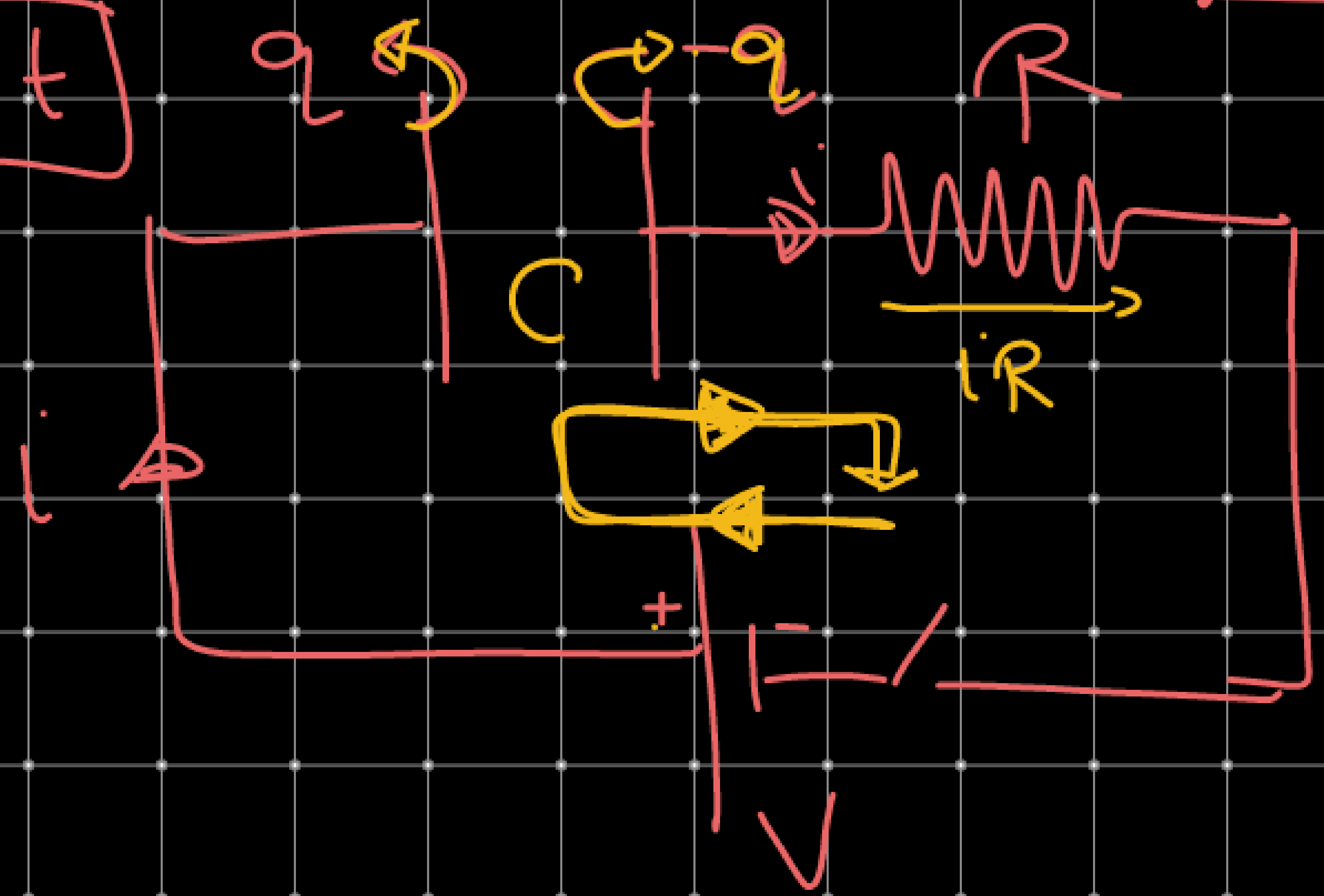
⇒ Charging of Capacitor:-

$\boxed{\text{at } t}$



at time t

↳ KVL.

$q = CV'$

$V' = \frac{q}{C}$

$q = C\,V'$

$V' = \frac{q}{C}$

$$V - \frac{q}{C} - iR = 0$$

$$\int_0^q \frac{dq}{CV-q} = \int_0^t \frac{dt}{RC}$$

$$\int \frac{dx}{b-x} =$$

$$\frac{CV-q}{C} = iR \qquad i = \frac{CV-q}{RC}$$

$$\frac{dq}{dt} = \frac{CV-q}{RC} \Rightarrow \frac{dq}{CV-q} = \frac{dt}{RC}$$

$$\boxed{q = CV\left(1-e^{-t/RC}\right)}$$

$$\boxed{\int_0^q \frac{dq}{CV-q} = \int_0^t \frac{dt}{RC}}$$

$$\int \frac{dx}{x} = \ln x$$

$$= -\ln \frac{CV-q}{CV} = \frac{1}{RC}t$$

$$\ln \frac{CV-q}{CV} = \frac{-t}{RC}$$

$$\frac{CV-q}{CV} = e^{-t/RC}$$

$$CV-q = CVe^{-t/RC}$$

$$q = CV - CVe^{-t/RC}$$

$$q = CV(1-e^{-t/RC})$$

$$\boxed{q = CV(1-e^{-t/RC})}$$

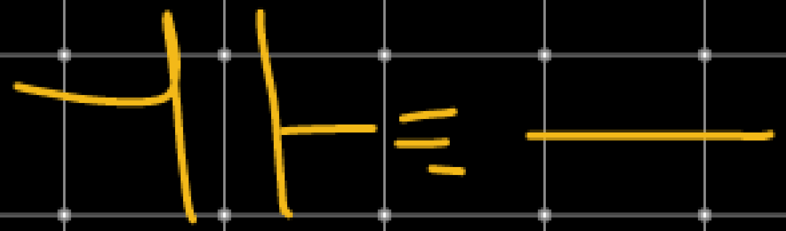
$$q = CV(1-e^{-t/RC})$$

$$\boxed{q = q_{max}(1-e^{-t/RC})}$$

$$\boxed{q = CV\left(1 - e^{-t/RC}\right)}$$

$$q = CV\left(1 - \frac{1}{e^{t/RC}}\right)$$

$\underline{\underline{t = 0}}$



$$q = CV\left(1 - \frac{1}{e^{0}}\right)$$

$$= CV\left(1 - \frac{1}{1}\right)$$

$$= CV(1-1)$$

$$\boxed{q = 0}$$

$\# \; t = \infty$

$$q = CV\left(1 - e^{-t/RC}\right)$$

$$q = CV\left(1 - \frac{1}{e^{t/RC}}\right)$$

$t = \infty$

$$q = CV\left(1 - \frac{1}{e^{\infty}}\right)$$

$$= CV\left(1 - \frac{1}{\infty}\right)$$

$$= CV(1 - 0)$$

$$\boxed{q = CV}$$

$t = \infty \rightarrow$ Capacitor will be fully charged.

$$q = CV\left(1 - e^{-t/RC}\right)$$

$$\boxed{RC = \tau = 1 \text{ time constant.}}$$

$$\left[\frac{t}{RC}\right]$$

$$[t] = [RC]$$

$$[RC] = [M^0 L^0 T]$$

$\Rightarrow$ Charge on capacitor when $t = RC = \tau$

$$q = CV\left(1 - e^{-RC/RC}\right)$$

$$q = CV\left(1 - e^{-1}\right)$$

$$= CV\left(1 - \frac{1}{e}\right)$$

$$\boxed{\frac{1}{e} = 0.37}$$

$$q = CV(1 - 0.37)$$

$$\boxed{q = 0.63\, CV}$$

$t = RC = \tau$ = Time Constant

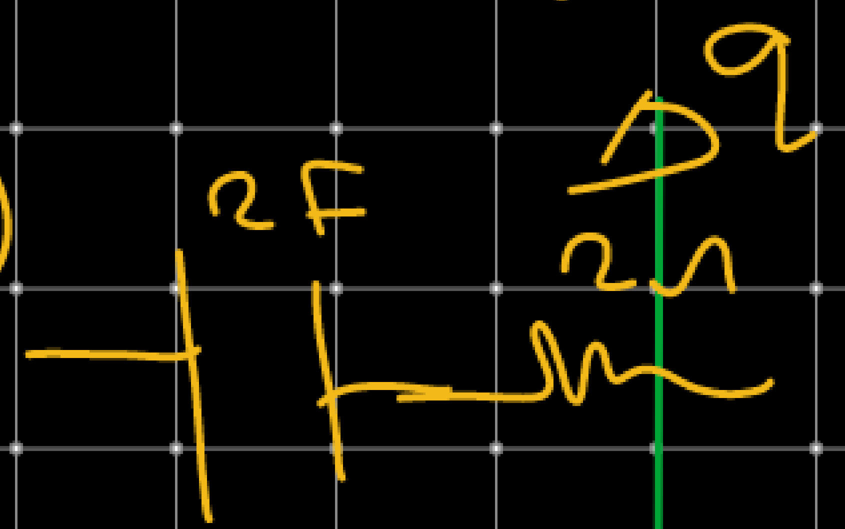
$q = CV(0.63)$

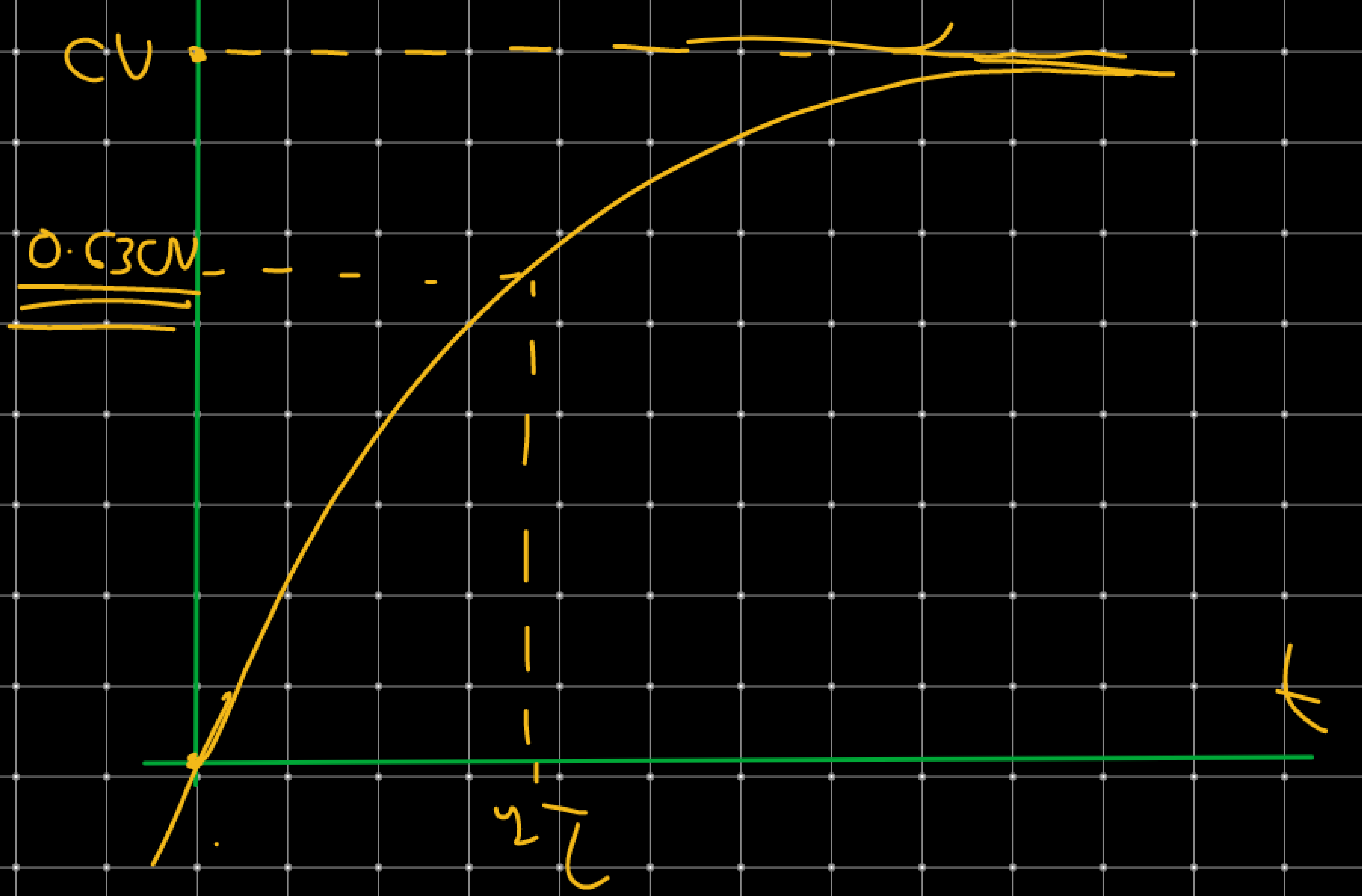
$q = 0.63\,CV$

$$\boxed{q = 0.63\, q_{max}}$$

at $t = \tau = RC$

↳ capacitor 63% charged





$\Rightarrow \quad q = CV(1 - e^{-t/RC})$

$t = 0, \quad q = 0$

$t = \infty \quad q = CV = q_{max}$

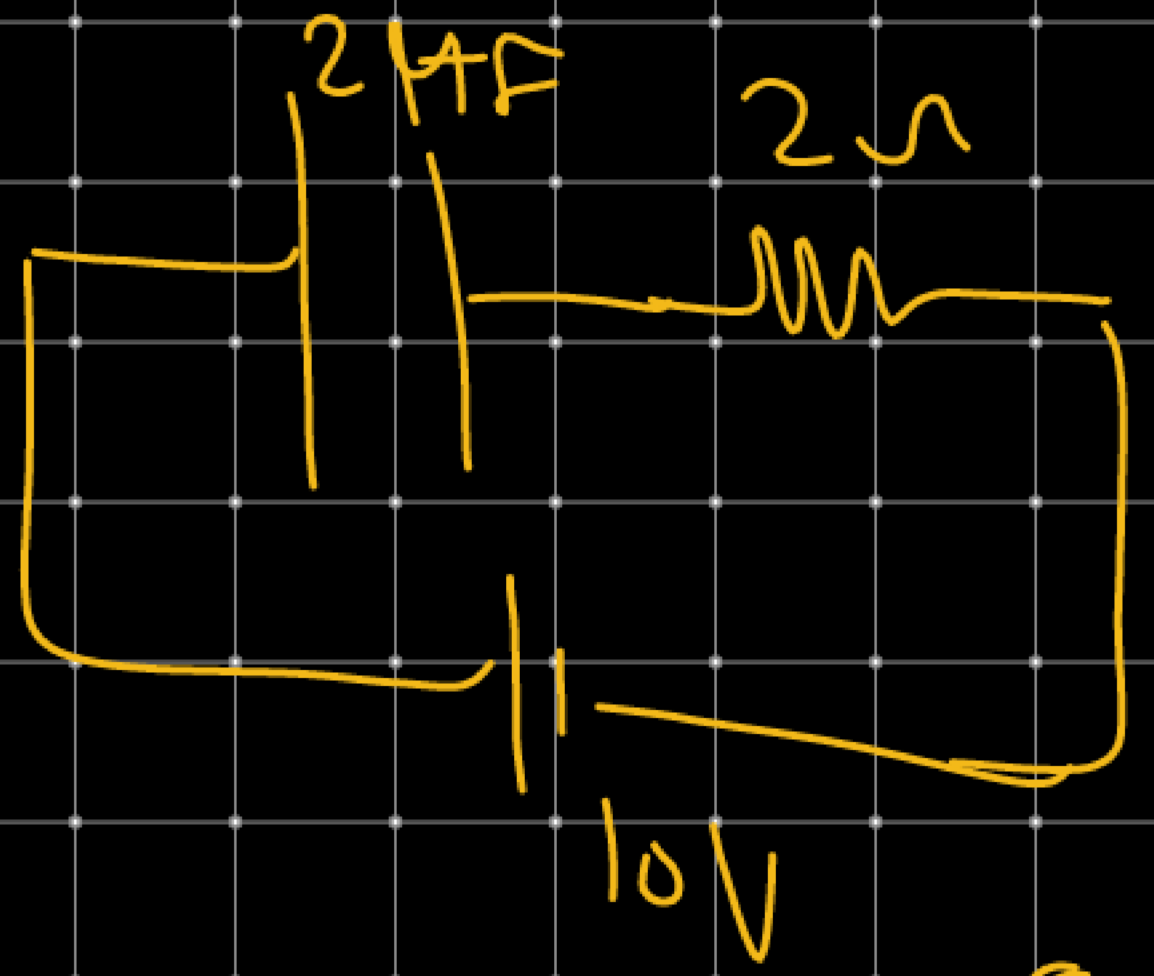
$t = RC = \tau, \quad q = 0.63\,CV$

$t = 0 \qquad q = 0$

$t = \infty \qquad q = CV$

$t = 1\tau = RC \qquad q = 0.63CV$

$$q = CV\left(1 - e^{-t/RC}\right)$$



$\underline{t = 4\,\text{sec}}$

$RC = 2 \times 2 \times 10^{-6}\,\text{sec}$

$= 4 \times 10^{-6}\,\text{sec}$

$q = 2 \times 10^{-6} \times 10\left(1 - e^{-\cancel{4}/\cancel{4}\times 10^{-6}}\right)$

$q = 2 \times 10^{-5}\left(1 - e^{-1\times 10^{6}}\right)$

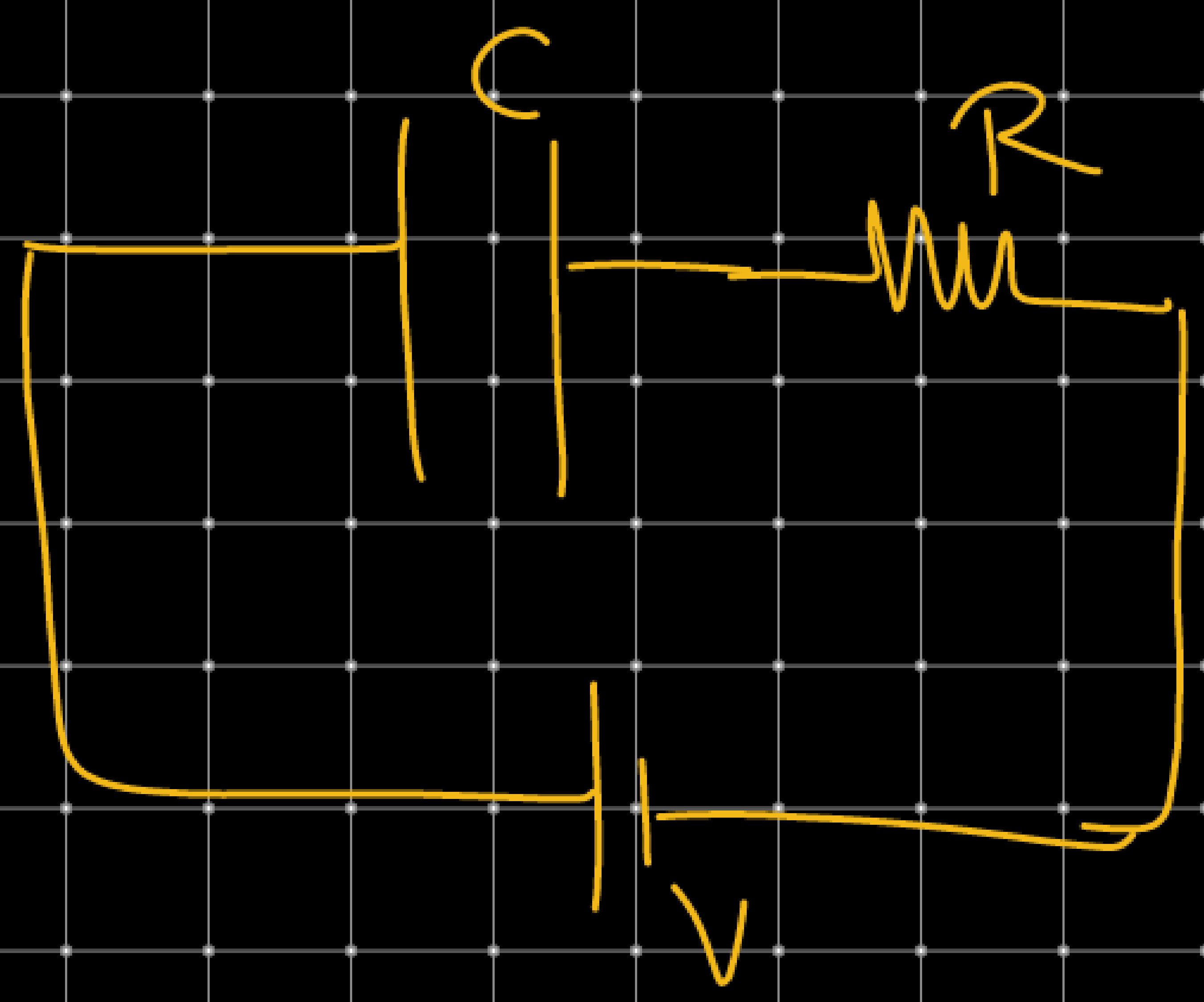
$= 2 \times 10^{-5}\left(1 - \frac{1}{e^{10^6}}\right)$

$$\boxed{\boxed{q = CV\left(1 - e^{-t/RC}\right)}}$$

#

$$q = CV\left(1 - e^{-t/RC}\right)$$

$$q = CV\left(1 - \frac{1}{e^{t/RC}}\right)$$



→ Equⁿ of current in RC-circuit

$$q = CV\left(1 - e^{-t/RC}\right)$$

$$i = \frac{dq}{dt} = \frac{d}{dt}\left(CV - CV e^{-t/RC}\right)$$

$$\frac{d}{dx} e^{x} = e^{x}$$

$$i = \frac{V}{R} e^{-t/RC}$$

$$q = CV(1 - e^{-t/RC})$$

$$q = CV - CVe^{-t/RC}$$

$$i = \frac{dq}{dt} = \frac{d}{dt}\left(CV - CVe^{-t/RC}\right)$$

$$i = \frac{d}{dt}CV - \frac{d}{dt}CVe^{-t/RC}$$

$$i = 0 - CVe^{-t/RC}\frac{d}{dt}(-t/RC)$$

$$= -\cancel{C}Ve^{-t/RC} \times -\frac{1}{R\cancel{C}}$$

$$i = \frac{V}{R}e^{-t/RC}$$

$$\frac{de^x}{dx} = e^x \times \frac{dx}{dx}$$

$$i = \frac{V}{R}e^{-t/RC}$$

$$i = \frac{V}{R} e^{-t/RC}$$

$$\boxed{i = \frac{V}{R} e^{-t/\tau}} \qquad \boxed{i_{max} = \frac{V}{R}}$$

$RC = \tau =$ Time Constant

$\underline{\underline{t = 0}}$

$$i = \frac{V}{R} \frac{1}{e^{t/RC}}$$

$$i = \frac{V}{R} \times \frac{1}{e^{0/RC}} = \frac{V}{R} \times \frac{1}{e^{0}} = \frac{V}{R}$$

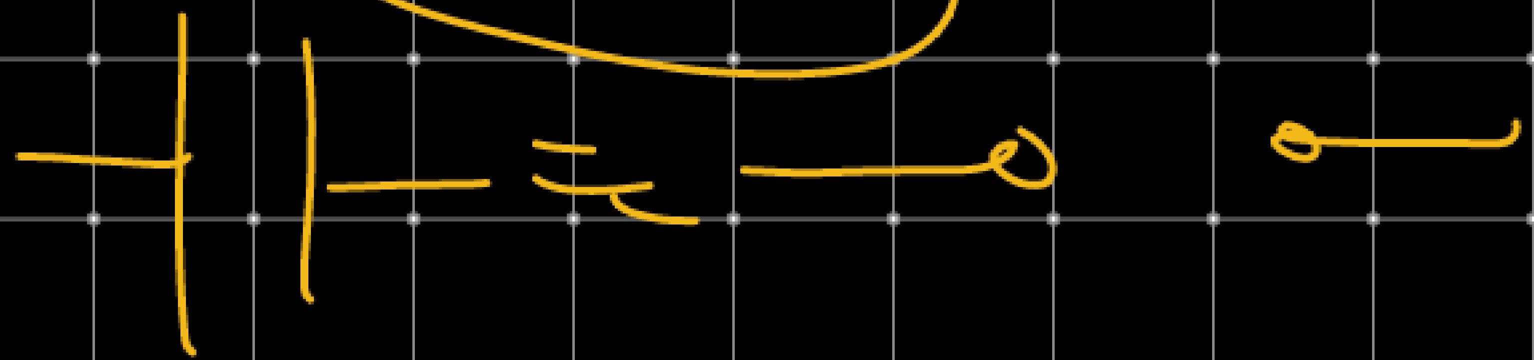
$$t = 0 \quad i = \frac{V}{R} = i_{max}$$

$\underline{\underline{t = \infty}}$

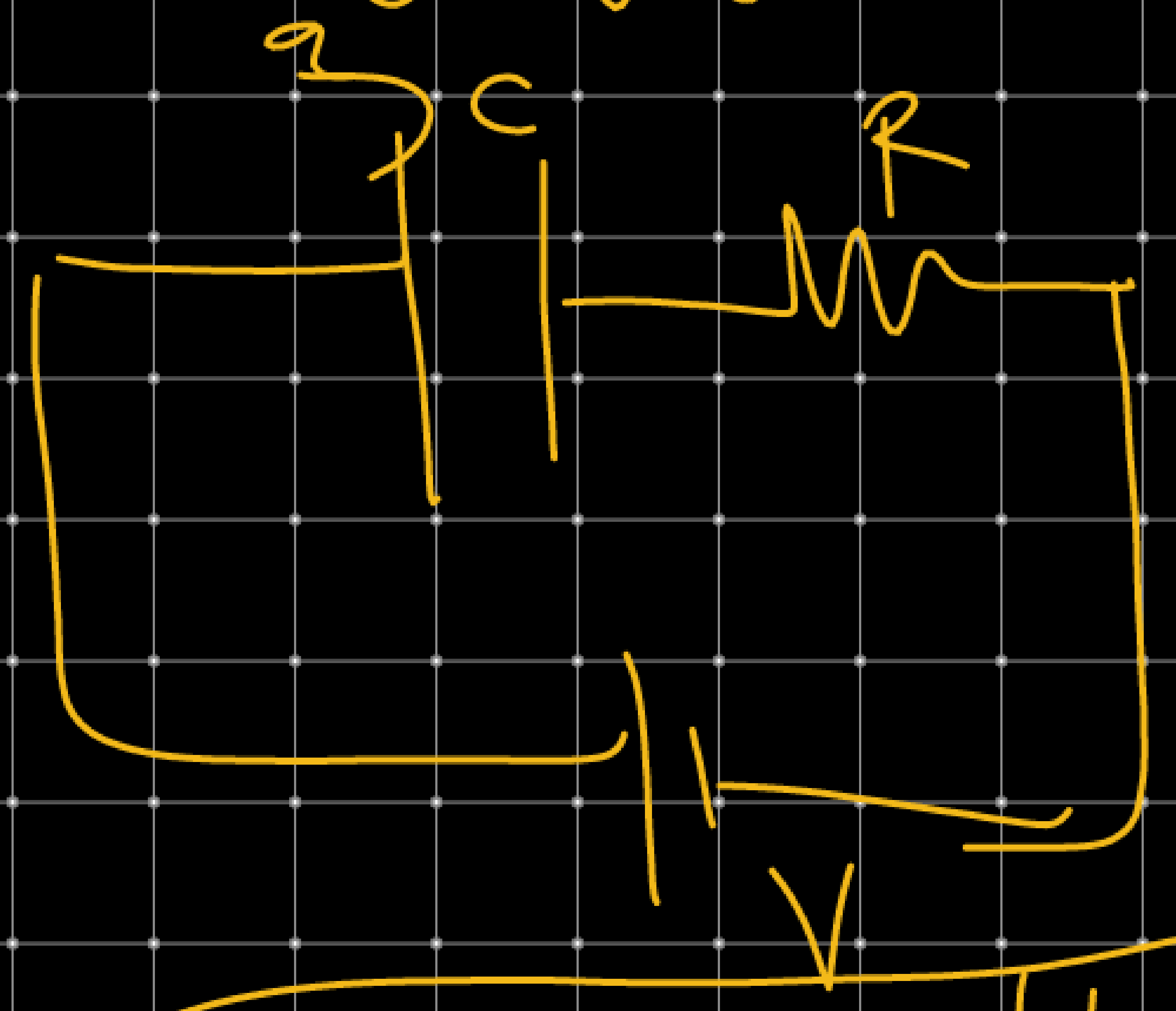
$$i = \frac{V}{R} \frac{1}{e^{t/RC}}$$

$$i = \frac{V}{R} \times \frac{1}{e^{\infty}} = \frac{V}{R} \times \frac{1}{\infty} = \underline{\underline{0}}$$

$$i = 0$$

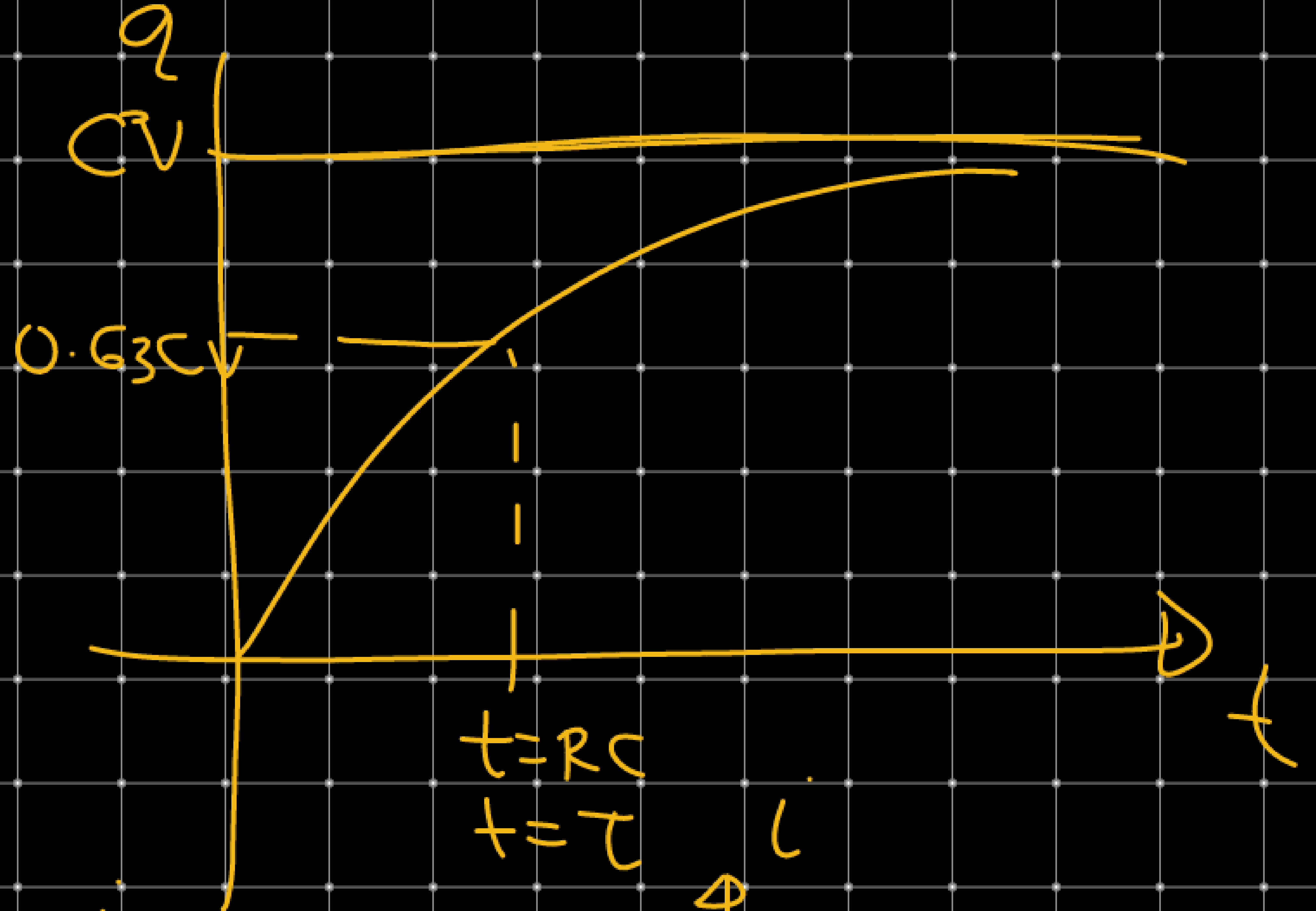
$t = \infty$ 

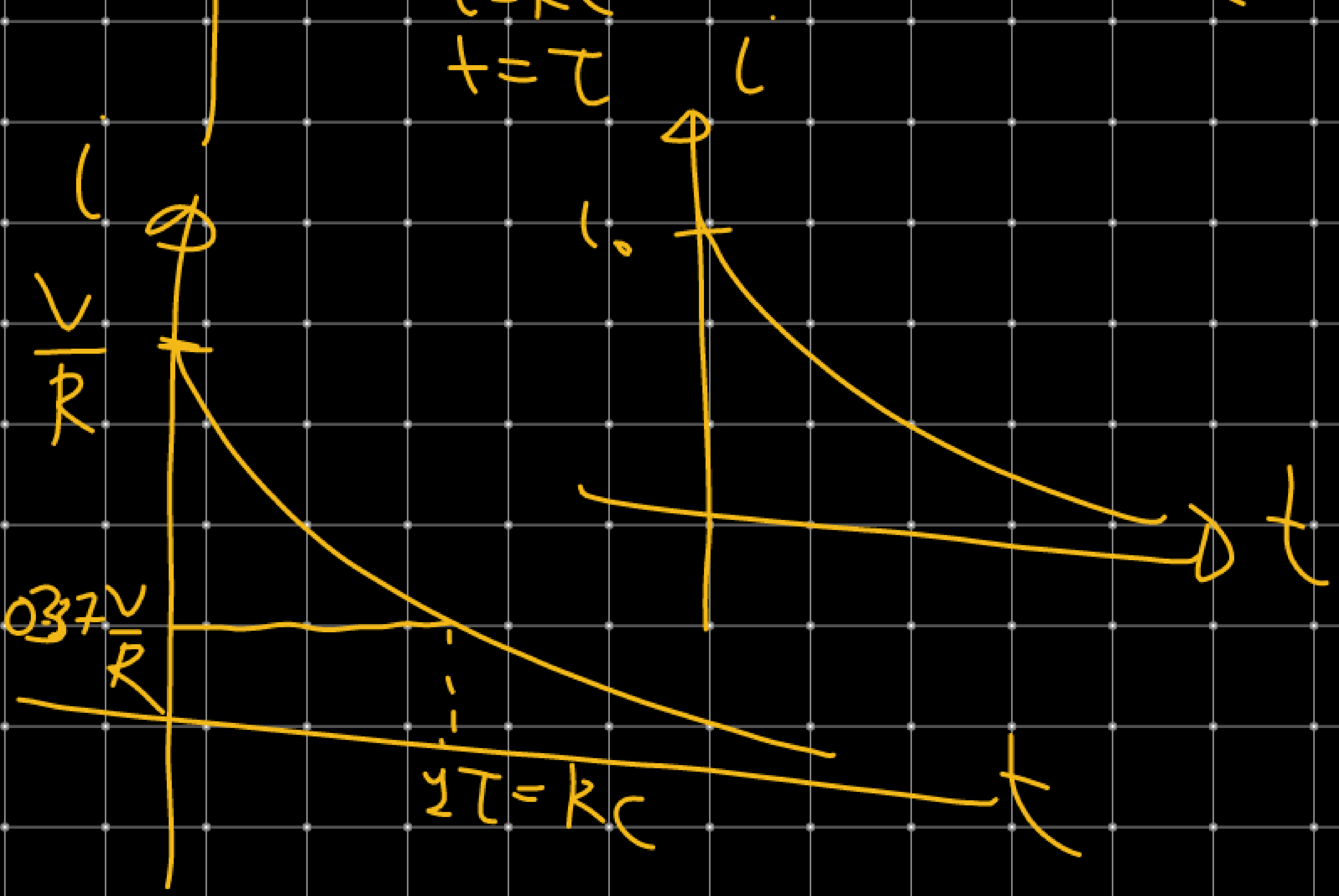
Charging of R-C Circuit



$$q = CV\left(1 - e^{-t/RC}\right)$$

$$i = \frac{V}{R} e^{-t/RC}$$





$$i = \frac{V}{R} e^{-t/RC}$$

$$i = \frac{V}{R e^{t/RC}}$$

$$i = \frac{i_0}{e^{t/RC}}$$

$$t = 0 \qquad i = i_0 = \frac{V}{R}$$

$$t = \infty \qquad i = \frac{i_0}{e^{\infty}} = 0$$

$$t = RC = \tau$$

$$i = \frac{V}{R e^{t/RC}}$$

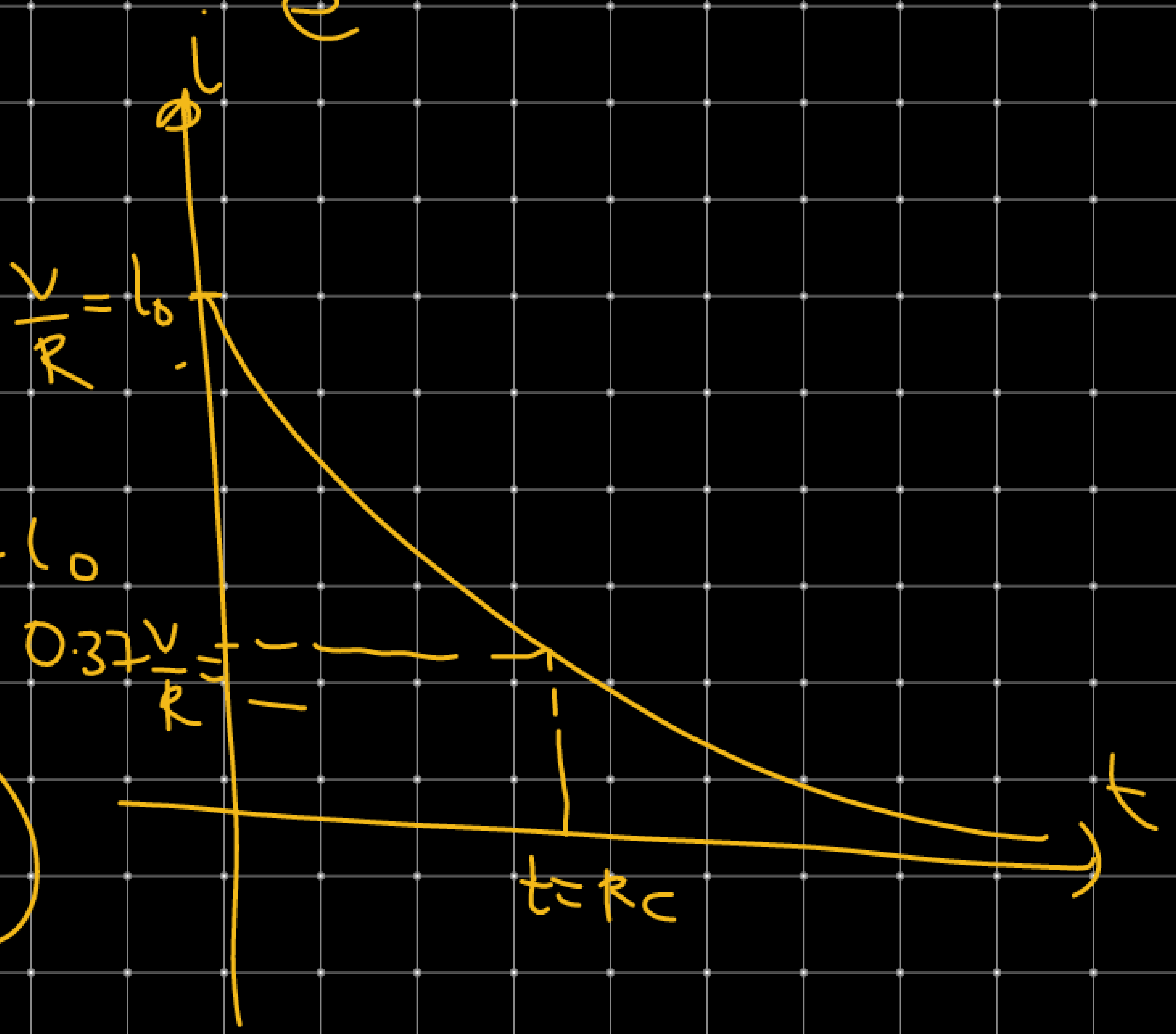
$$i = \frac{V}{Re}$$

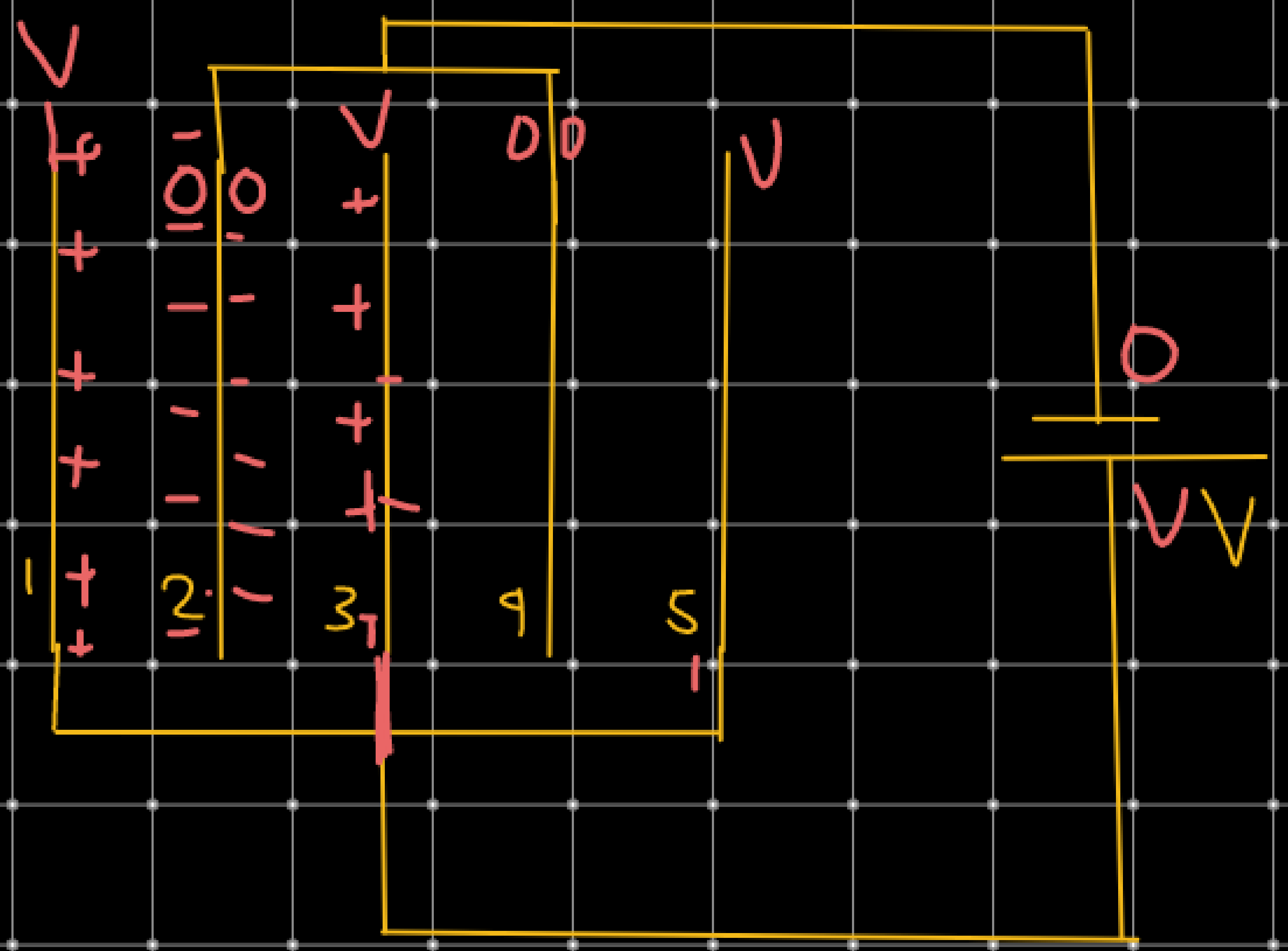
$$i = \frac{i_0}{e}$$

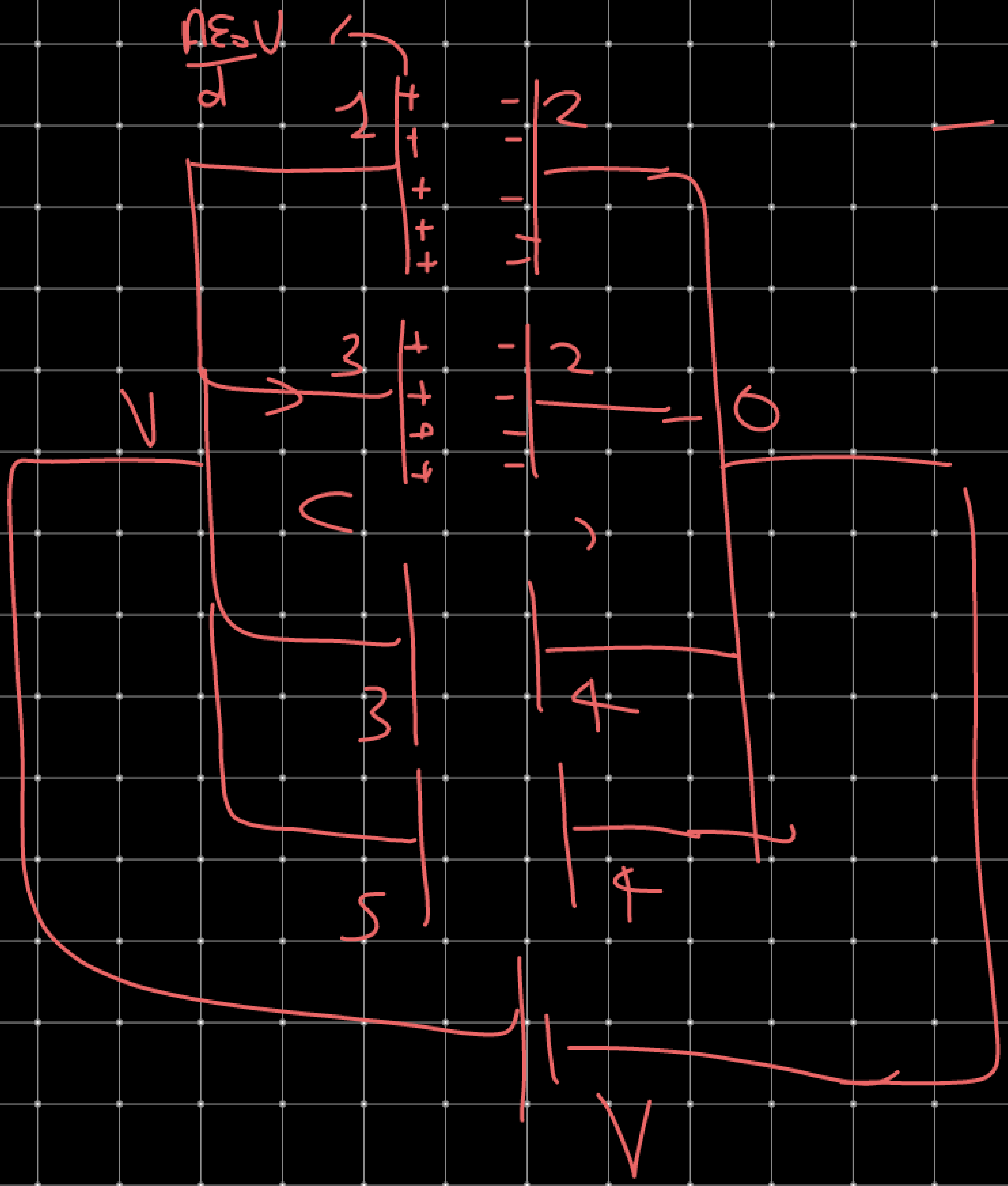
$$= \frac{1}{e} i_0 = 0.37 i_0$$

$$i = 0.37 \frac{V}{R}$$

$$\frac{1}{e} = 0.37$$




V
0 0
V
0 0
V
0
V V
1
2
3
4
5


Aε₀V/d
1
2
3
2
V
0
3
4
5
4
V