Ex) Ables sheet

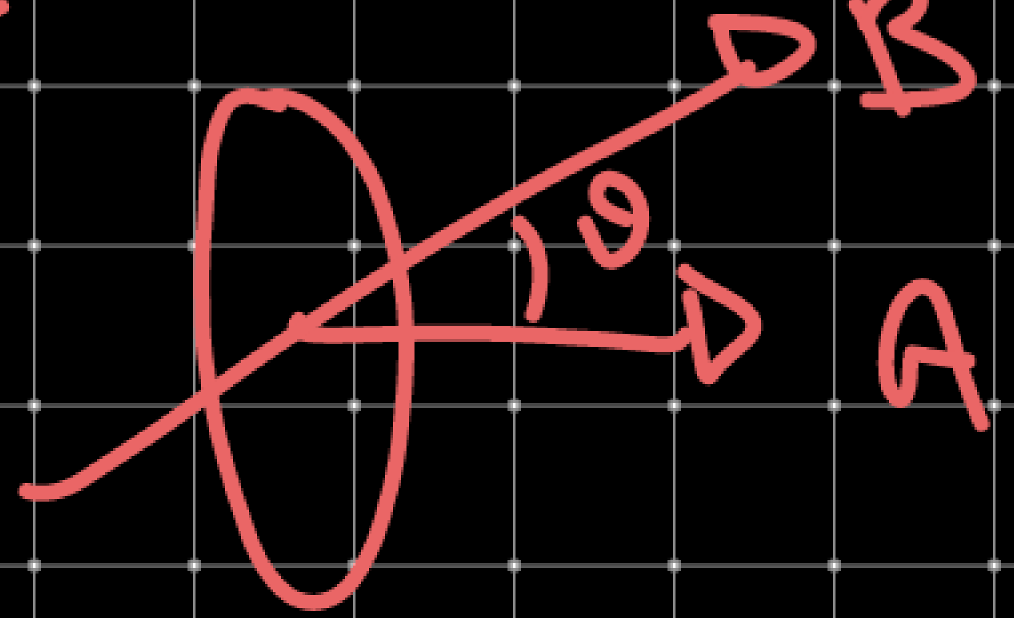
Q1, Q3, Q4, Q5, Q7, Q8, Q27,

34 YPYQP (NEET) Q1 → to 20

NCERT - 1 to 10

JEE Main → 1 to 20

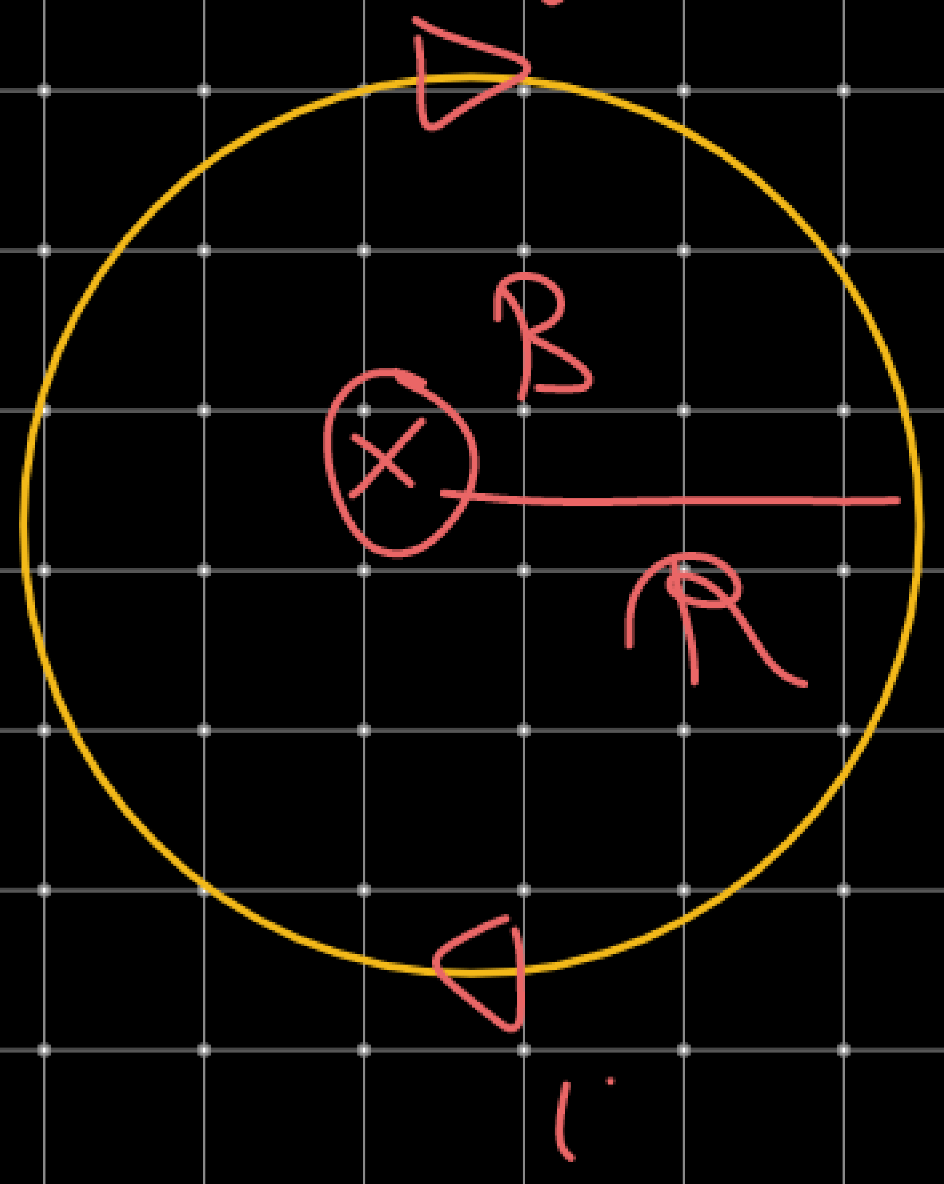
- Static Induction (B → change)
  - Self Induction
  - Mutual Induction
- Dynamic Induction [A - change]
- Periodic Inductor. [θ - change]



Static Induction

Self Induction

$\boxed{\rightarrow B \rightarrow \text{changes}}$



$i\uparrow \quad B\uparrow \quad \phi\uparrow$

$B = \frac{\mu_0 i}{2R}$

$\phi = BA\cos\theta$

$\phi = \frac{\mu_0 i}{2R}(\pi R^2)$

$\phi \propto i$

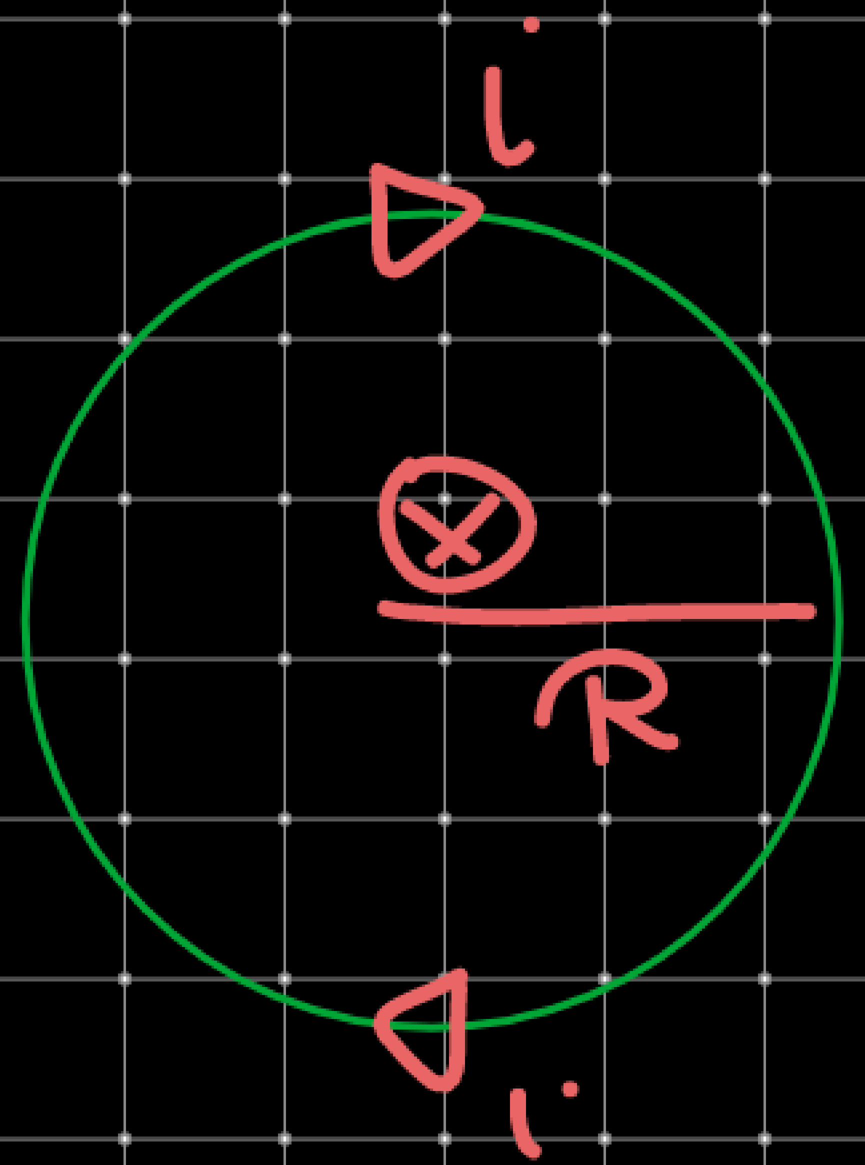
$\phi = Li$

$\phi \propto i$

$i\downarrow, B\downarrow, \phi\downarrow$

$\phi \propto i$

Self Induction of Circular coil:



(i) $B_c = \frac{\mu_0 i}{2R}$

(ii) $\phi = BA\cos 0$

$= \frac{\mu_0 i}{2\cancel{R}} \times \pi R^{\cancel{2}}$

$\phi = \frac{\mu_0 i \pi R}{2}$

(iii) $\phi = Li$

$L = \frac{\phi}{i}$

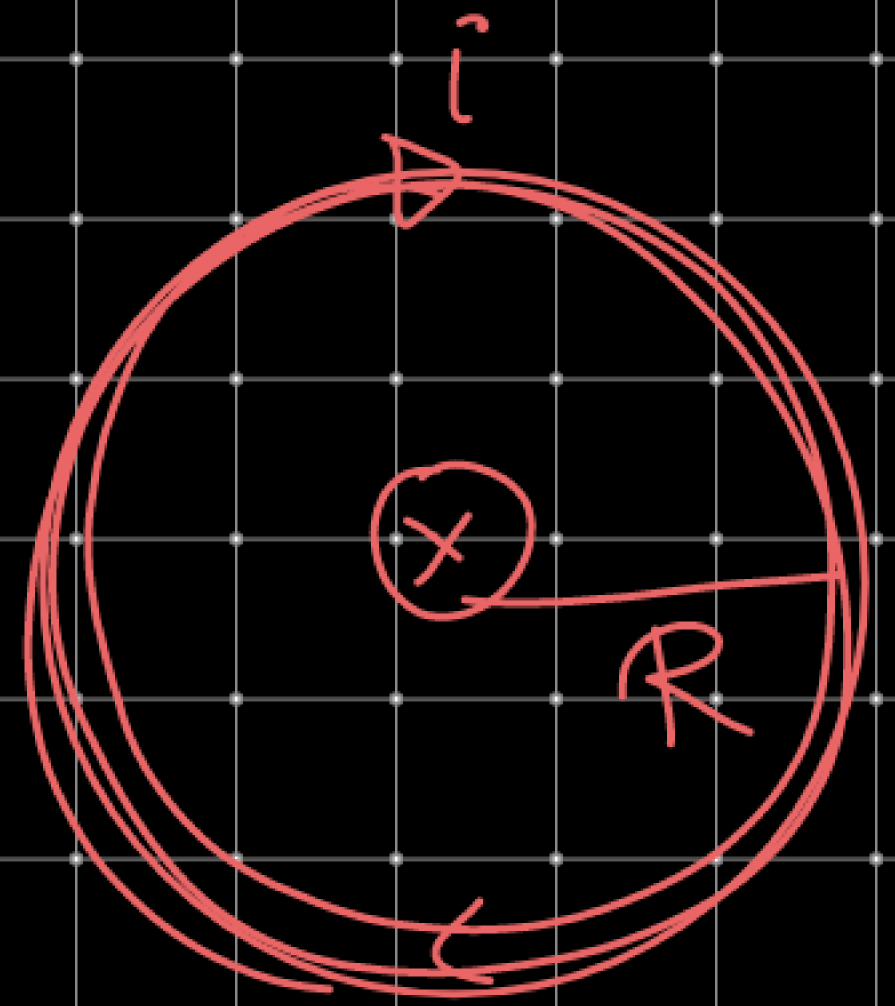
$L = \frac{\mu_0 \cancel{i} \pi R}{2 \times \cancel{i}}$

$$\boxed{L = \frac{\mu_0 \pi R}{2}}$$

L - Inertia of electricity

L → does not depend on i, B,

Self Induction of N-turn coil, carrying current i.



(i) $B_c = \frac{\mu_0 N i}{2R}$

(ii) $\phi = BA = \frac{\mu_0 N i}{2\cancel{R}} \times N \pi R^{\cancel{2}}$

$\phi = \frac{\mu_0 i N^2 \pi R}{2}$

(iii) $\phi = Li$

$L = \frac{\phi}{i} = \frac{\mu_0 N^2 \pi R}{2}$

(iv) If coil placed in medium

$L_m = \frac{\mu_0 \mu_r N^2 \pi R}{2}$

↳ depends on R, N & medium.

$$\phi \propto i$$

$$\phi = Li$$

$L =$ Co-efficient of Self Induction

$$L = \frac{\phi}{i} = \frac{Wb}{Amp} = \text{Henry } (H)$$

↳ SI Unit → Henry.

$L \rightarrow$ does not depends on i, B.

$\Rightarrow$ Self Induction of N-turn coil $\rightarrow$

$$\boxed{\boxed{L_m = \frac{\mu_0 \mu_r N^2 \pi R}{2}}}$$

Self Induction of Circular Coil of Radius R depends On :-

$$L = \frac{\mu_0 \mu_r N^2 \pi R}{2}$$

(i) $L \propto R$

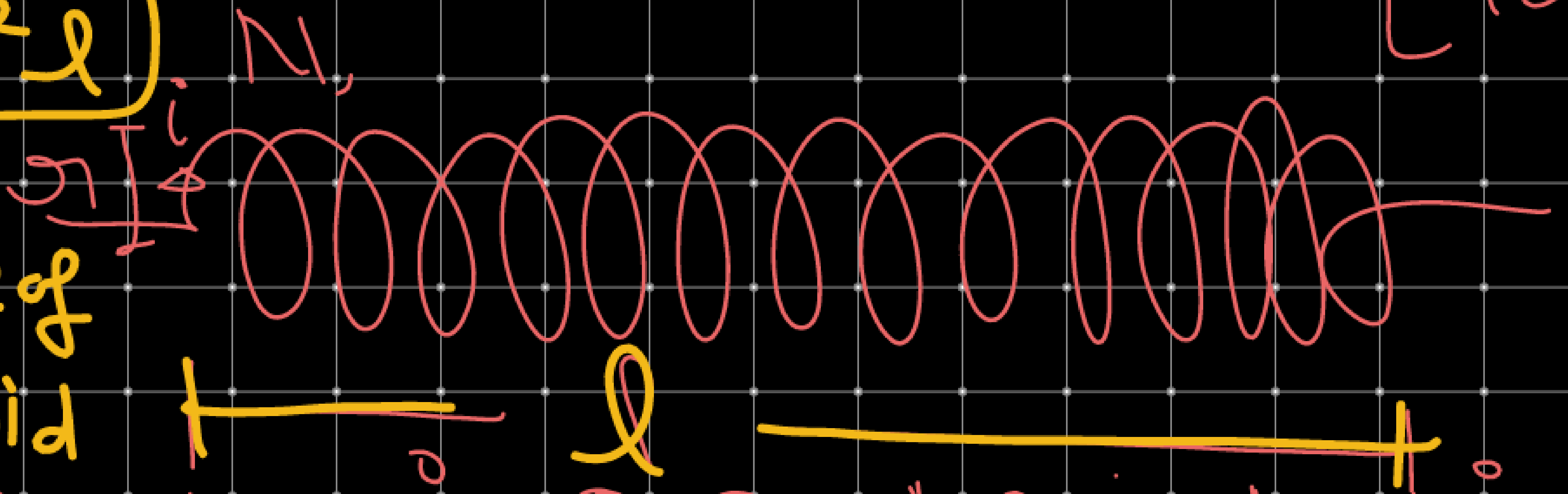
(ii) $L \propto N^2$

(iii) $L \propto \mu_r$

(iv) All of these ✓

⇒ Self Induction of Solenoid having turn density n, Number of turn N, radius of coil r, & length of Solenoid l, $[l >> r]$ [long Solenoid]

$\boxed{V = \pi r^2 l}$ → Volume of Solenoid



$$\boxed{n = \frac{N}{l}}$$

$$B = \mu_0 n i$$

$$B = \frac{\mu_0 N i}{l}$$

(i) $B = \mu_0 n i = \frac{\mu_0 N i}{l}$

$$L = \frac{\phi}{i}$$

(ii) $\phi = NBA = N \frac{\mu_0 N i}{l} \times \pi r^2$ $L = \frac{\mu_0 N^2 \pi r^2}{l}$

$$\phi = \frac{\mu_0 N^2 \pi r^2 i}{l}$$

$$L = \frac{\mu_0 N^2 \pi r^2}{l}$$

$$L_m = \frac{\mu_0 \mu_r N^2 \pi r^2}{l}$$

$L \propto N^2$

$L \propto r^2$

$L \propto \mu_r$

$$n = \frac{N}{l}$$

$$N = nl$$

$$L = \frac{\mu_0 n^2 l^{\cancel{2}} \pi r^2}{\cancel{l}}$$

$$\boxed{L = \mu_0 n^2 \pi r^2 l}$$

$$L = \mu_0 n^2 V$$

$$L_m = \mu_0 \mu_r n^2 V$$

$$\Rightarrow \boxed{\varepsilon_{ind} = -\frac{d\phi}{dt}}$$

$$i_{ind} = \frac{\varepsilon_{ind}}{R} = -\frac{1}{R}\frac{d\phi}{dt}$$

$$q_{flow} = \left|\frac{d\phi}{R}\right|$$

$$\Rightarrow \boxed{\phi = Li}$$

$$L_{circular\,coil} = \frac{\mu_0 \mu_r \pi R}{2}$$

$$L_{solenoid} = \mu_0 n^2 \text{ Volume}$$

$$(L_{solenoid})_m = \mu_0 \mu_r n^2 (A\ell)$$

$$\boxed{(L_{sol})_m = \frac{\mu_0 N^2 \pi r^2}{\ell}}$$

$$\Rightarrow \varepsilon_{ind} = -\frac{d\phi}{dt}$$

$$\varepsilon_{ind} = -\frac{d\phi}{dt}$$

$$\boxed{\boxed{\phi = Li}}$$

$$\varepsilon_{ind} = -\frac{d}{dt}(Li)$$

$L \rightarrow$ SI Unit $\frac{Wb}{Amp}$

$$\boxed{\varepsilon_{ind} = -L\frac{di}{dt}}$$

$||$

Henry = $\underline{\underline{H}}$

$$\boxed{\boxed{\varepsilon_{ind} = -L\frac{di}{dt}}}$$

L → How to find L :-

1. B

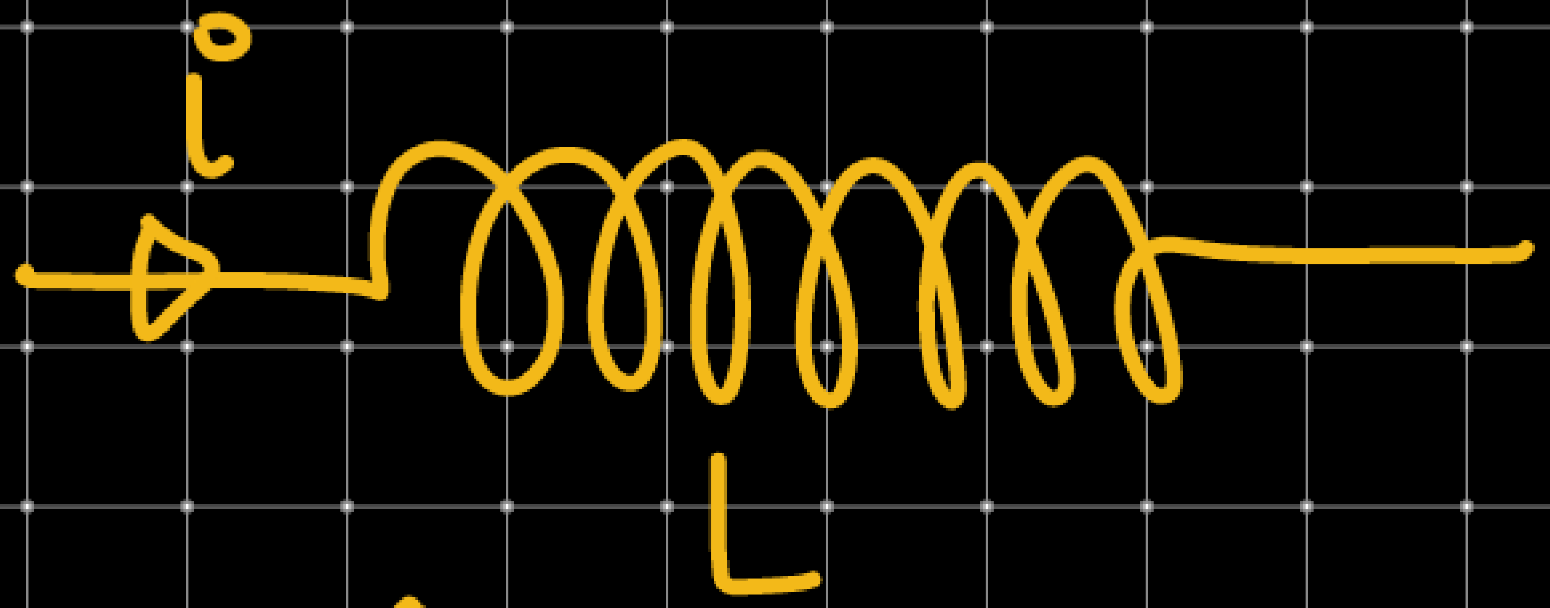
2. ϕ

3. $L = \dfrac{\phi}{i}$

$\phi = Li$

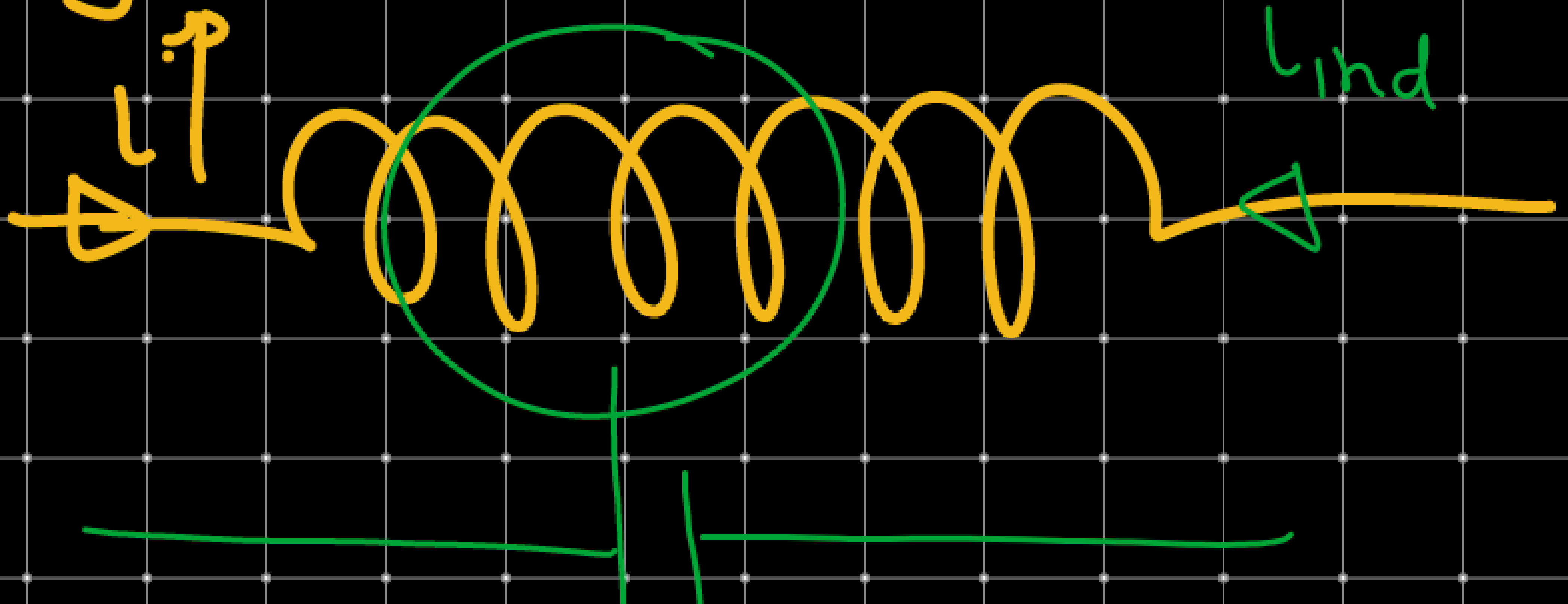
$L = \dfrac{\phi}{i}$

$\Rightarrow$

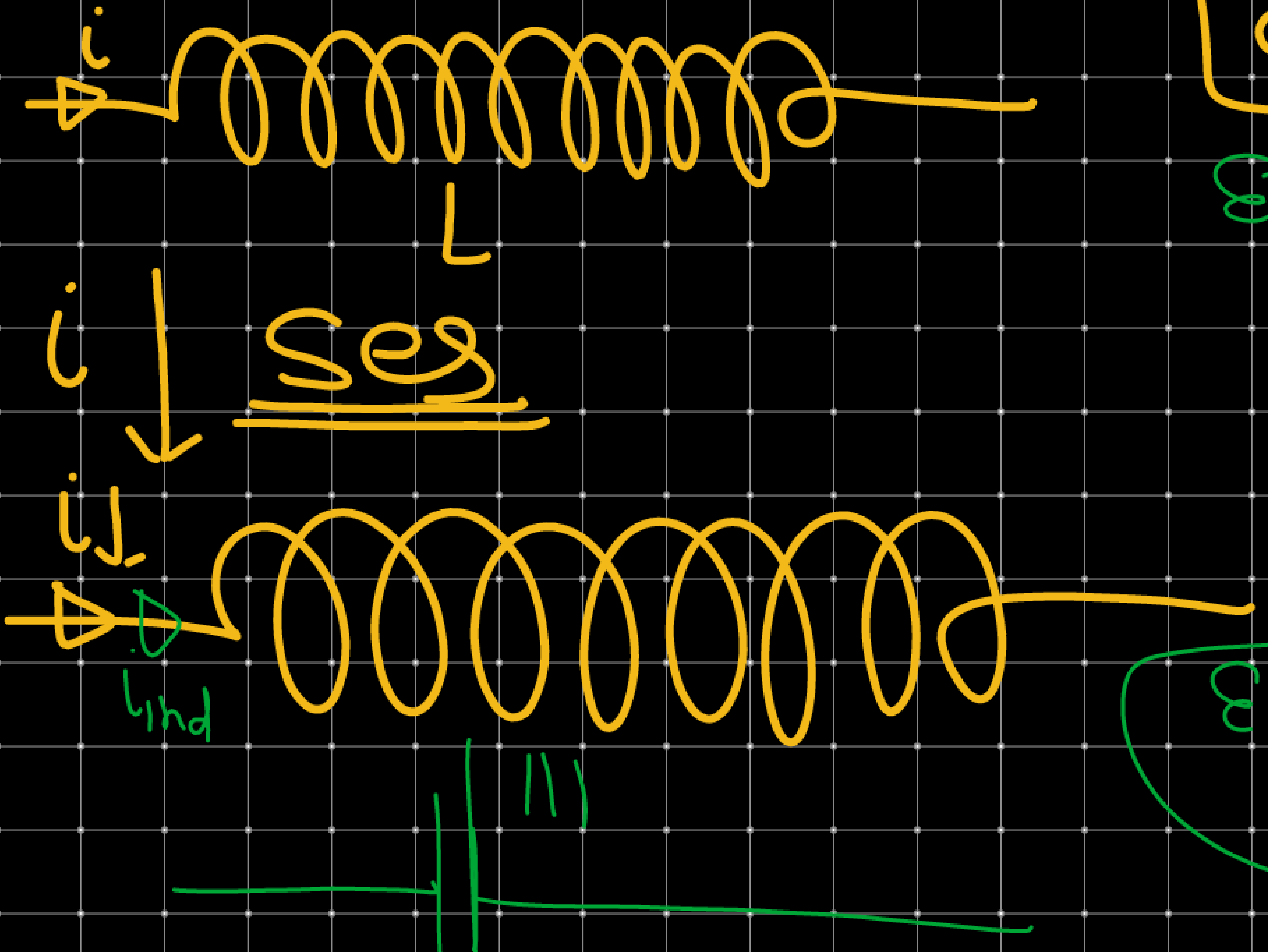


$i \uparrow \quad B \uparrow \quad \phi \uparrow$

$\Rightarrow$ If $i \uparrow$ sec.



$$\mathcal{E}_{ind} = L\frac{di}{dt}$$



$$\boxed{\phi = Li}$$

$$\mathcal{E}_{ind} = -\frac{d\phi}{dt}$$

$$= -\frac{d}{dt}(Li)$$

$$= -L\frac{di}{dt}$$

$$\mathcal{E}_{ind} = -L\frac{di}{dt}$$

$$\mathcal{E}_{ind} = L\frac{di}{dt}$$

Q1) If L coil = 5H then find induced Emf if.

(i) Current increasing at the rate 2amp/sec

(ii) " decreasing at " " 2amp/sec

Sol) (i) $\frac{di}{dt} = 2$ Amp/sec

$i_f > i_i$ $di = +ive$

$$\mathcal{E}_{ind} = -L\frac{di}{dt} = -5\times 2 = -10\,\text{Volt}$$

(ii) $\frac{di}{dt} = -2$ Amp/sec.

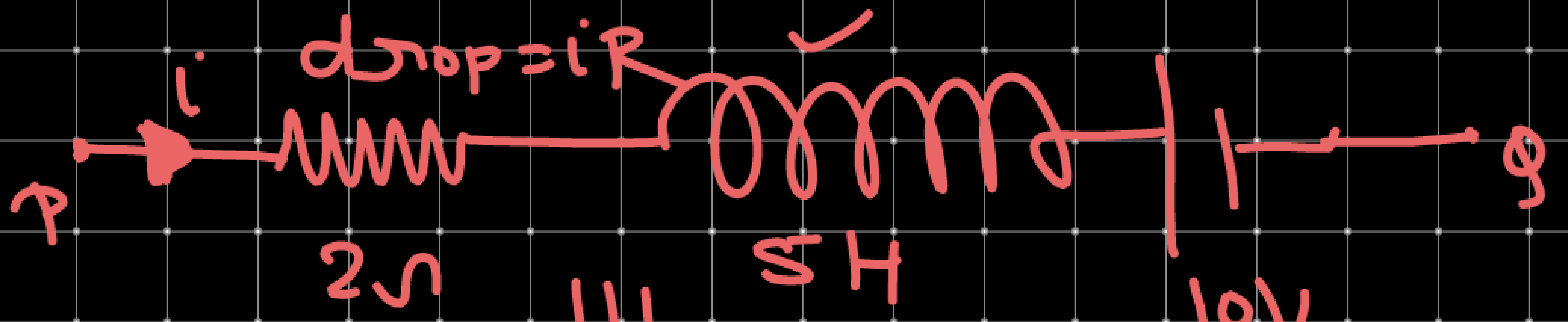
$i_f < i_i$ $di = -ive$

$$\mathcal{E}_{ind} = -L\frac{di}{dt} = -5\times(-2) = 10\,\text{Volt}$$

[Always opp the change]

Q1) find $V_P - V_Q$ when i is 2 Amp.

drop = iR



$\frac{di}{dt} = 2\,\text{Amp/sec}$

NEET

$V_P - 2\times2 - 10 - 10 = V_Q$

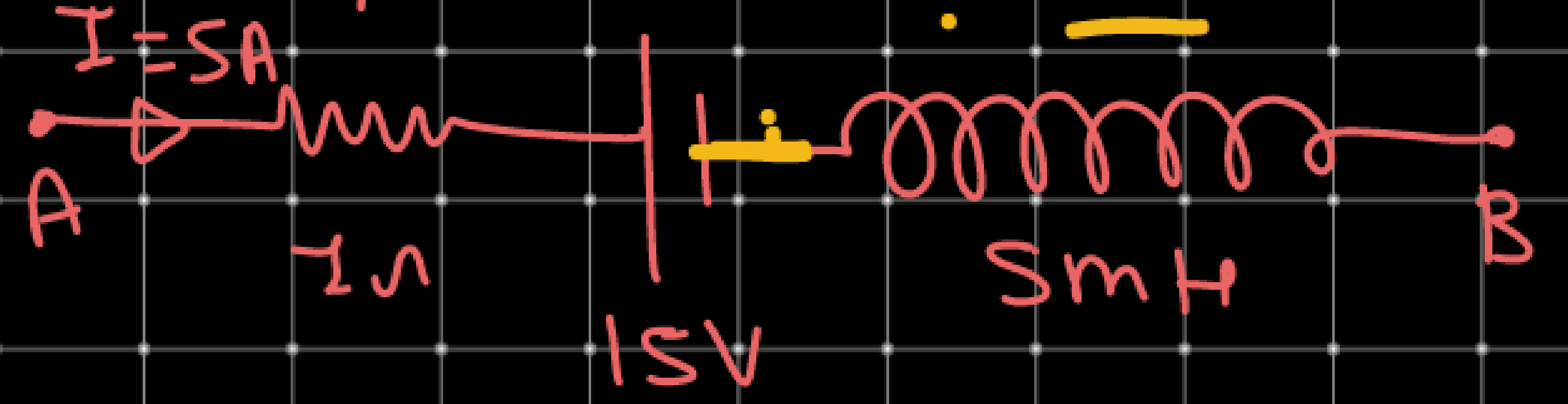
$V_P - V_Q = 24\,\text{Volt}$

$L\frac{di}{dt}$

$= 5\times2$

$= 10\,\text{Volt}$

Q) find $V_A - V_B$ is given circuit If



(I) Current is decreasing at the rate of 10^3 Amp/sec.

(II) " " increasing at " " " " " "

(III) Current is constant.

Sol) (1) $\frac{di}{dt} = -10^3$ Amp/sec $\quad \mathcal{E}_{ind} = -L\frac{di}{dt} = -5 \times \cancel{10^{-3}} H \times -\cancel{10^3}$

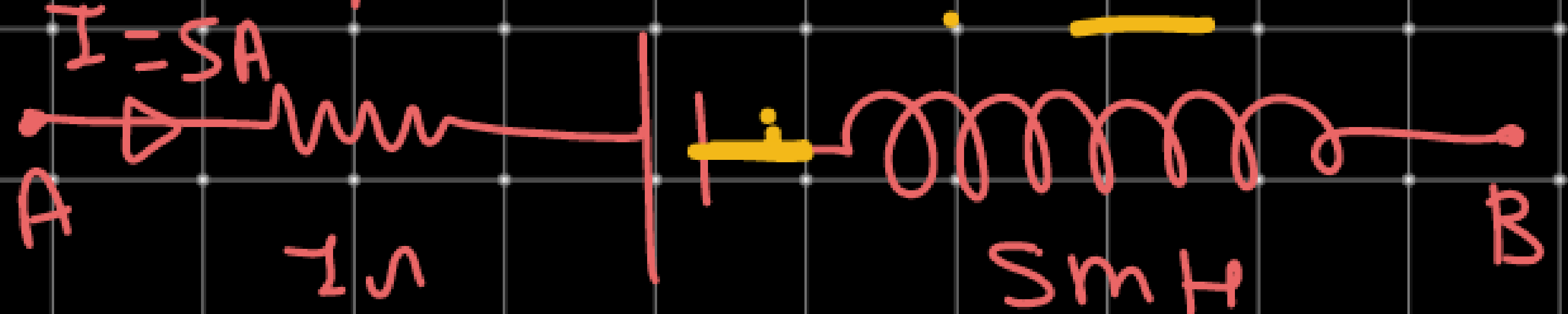
$= +5$ Volt

$\mathcal{E}_{ind} \Rightarrow (+) \rightarrow$ means $\rightarrow$ Support dirn of Current.

$V_A - \cancel{5} \times 1 - 15 + \cancel{5} = V_B$

$V_A - V_B = 15$ Volt

Q) Find $V_A - V_B$ is given circuit If



(i) Current is decreasing at the rate of 10^3 Amp/sec.

(ii) " " increasing at " " " " ".

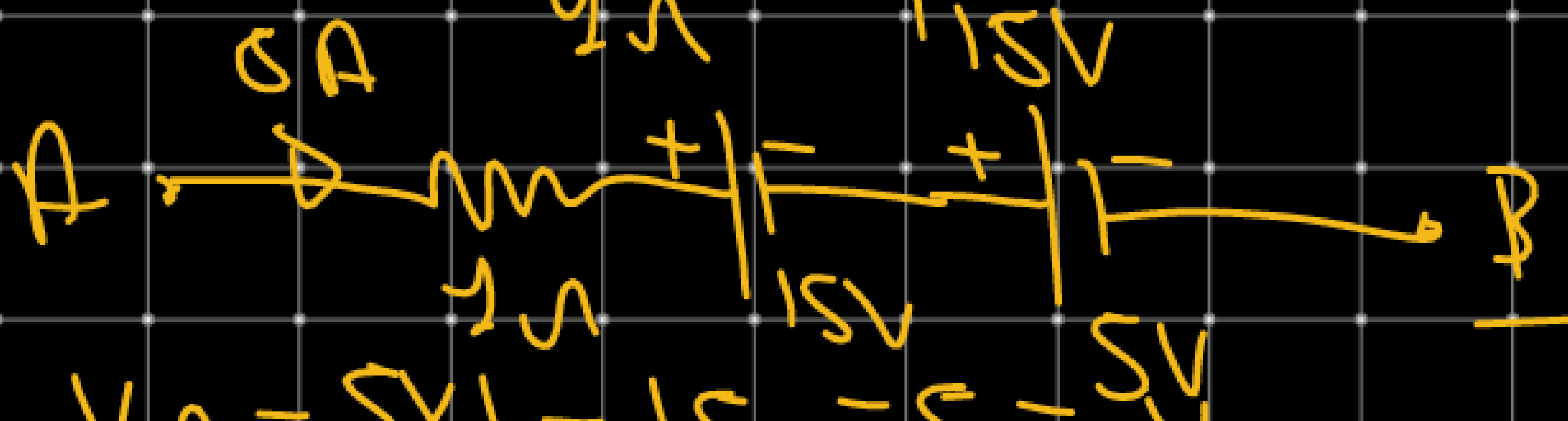
Curren

Sol (ii) $\frac{dI}{dt} = 10^3$ Amp/sec.

$\mathcal{E}_{ind} = -L\frac{di}{dt} = -5 \times \cancel{10^{-3}} \times \cancel{10^3}$

$= -5$ Volt

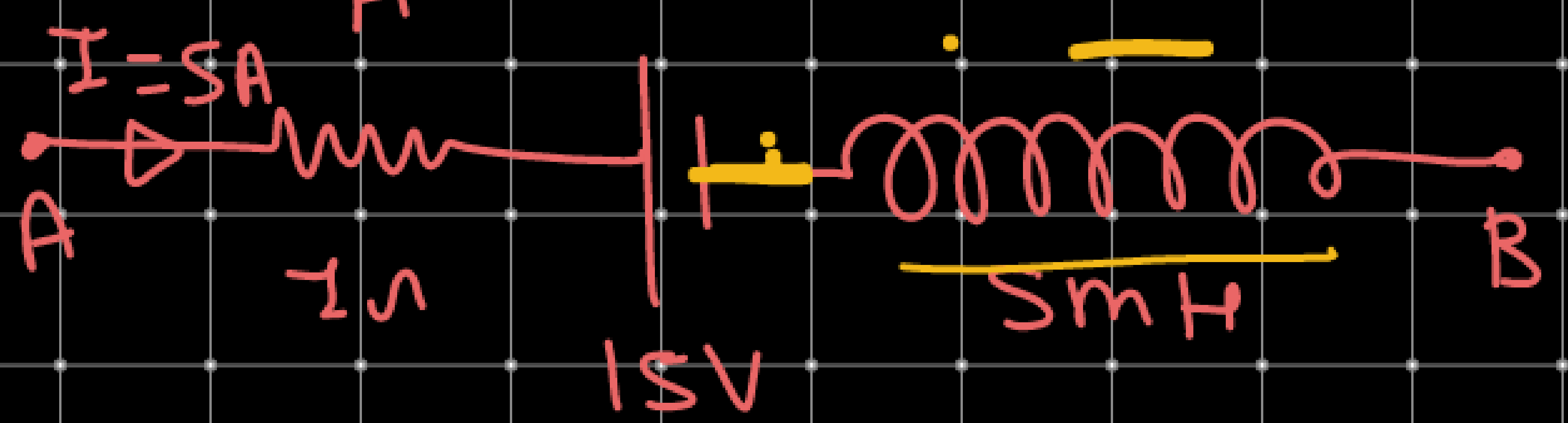
opp to dir^n of current.



$V_A - 5\times1 - 15 - 5 = V_B$

$V_A - V_B = 25$ Volt

Q) Find $V_A - V_B$ is given circuit If



(i) Current is decreasing at the rate of 10^3 Am/sec.

(ii) " " increasing at " " " " " "

(iii) Current is constant.

$$\frac{di}{dt} = 0 \qquad i = \text{Constant}$$

$$E_{ind} = 0$$

$$\boxed{V_A - V_B = 20 \text{ Volt}}$$

$$V_A - 5\times 1 - 15 = V_B$$

$$L_{Coil} = \frac{\mu_0 \mu_r N^2 \pi R}{2}$$

$$\boxed{L = \frac{\mu_0 \mu_r N^2 \pi R}{2}}$$

$$L_{Solenoid} = \frac{\mu_0 \mu_r N^2 \pi r^2}{l}$$

$$L_{Solenoil} = \mu_0 \mu_r n^2 \, Volume$$

$$= \mu_0 \mu_r n^2 \pi r^2 l$$

Q1) Current in a coil is 2amp & flux with each each turn is 10 mWb. If total turn are 500 then find Self Inductance of coil.

Sol)

$$\phi = L i$$

$$i = 2\,amp$$

$$\phi = 10 \times 10^{-3}\,Wb = 10^{-2}\,Wb$$

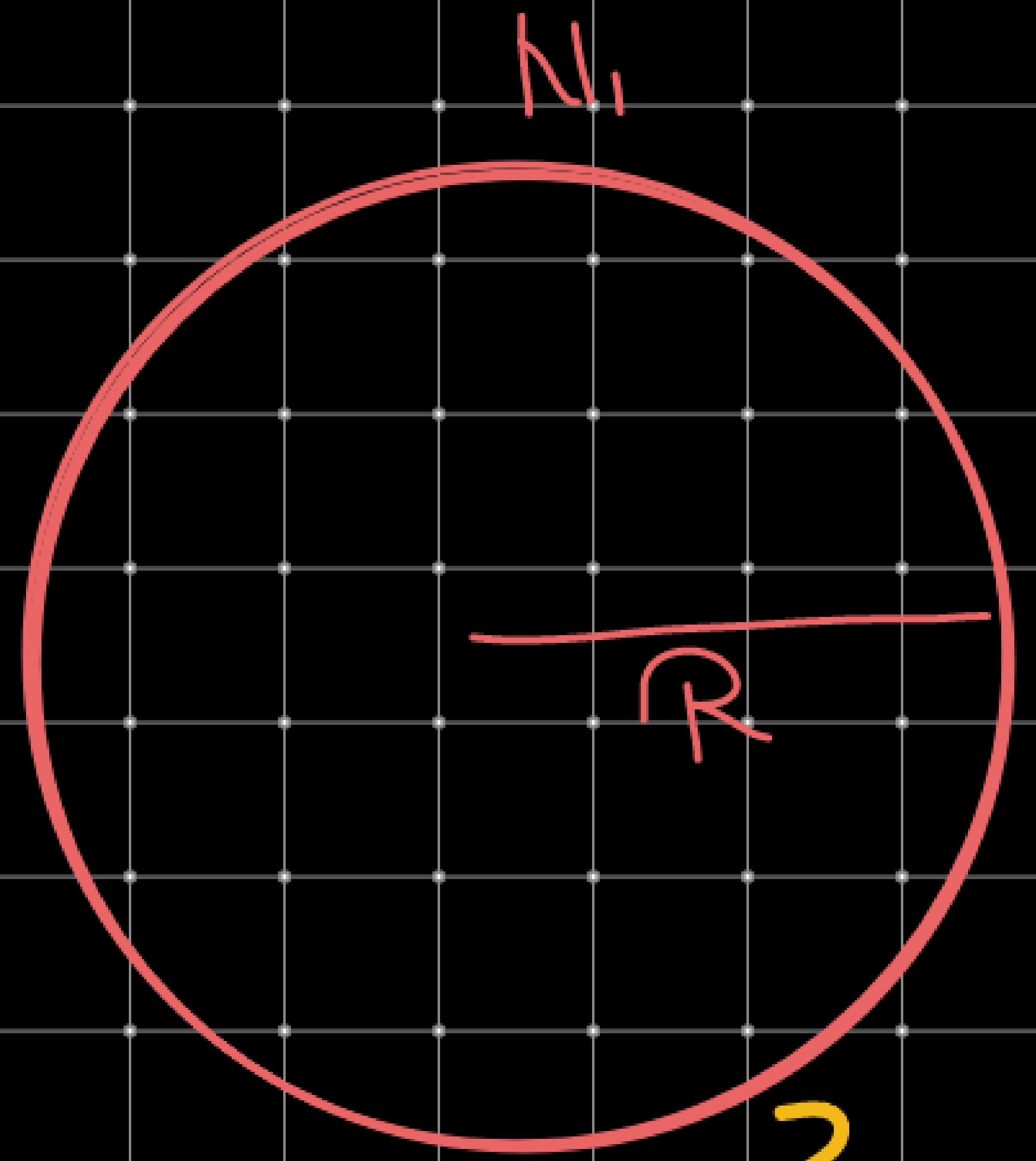
$$L = \frac{\phi}{i}$$

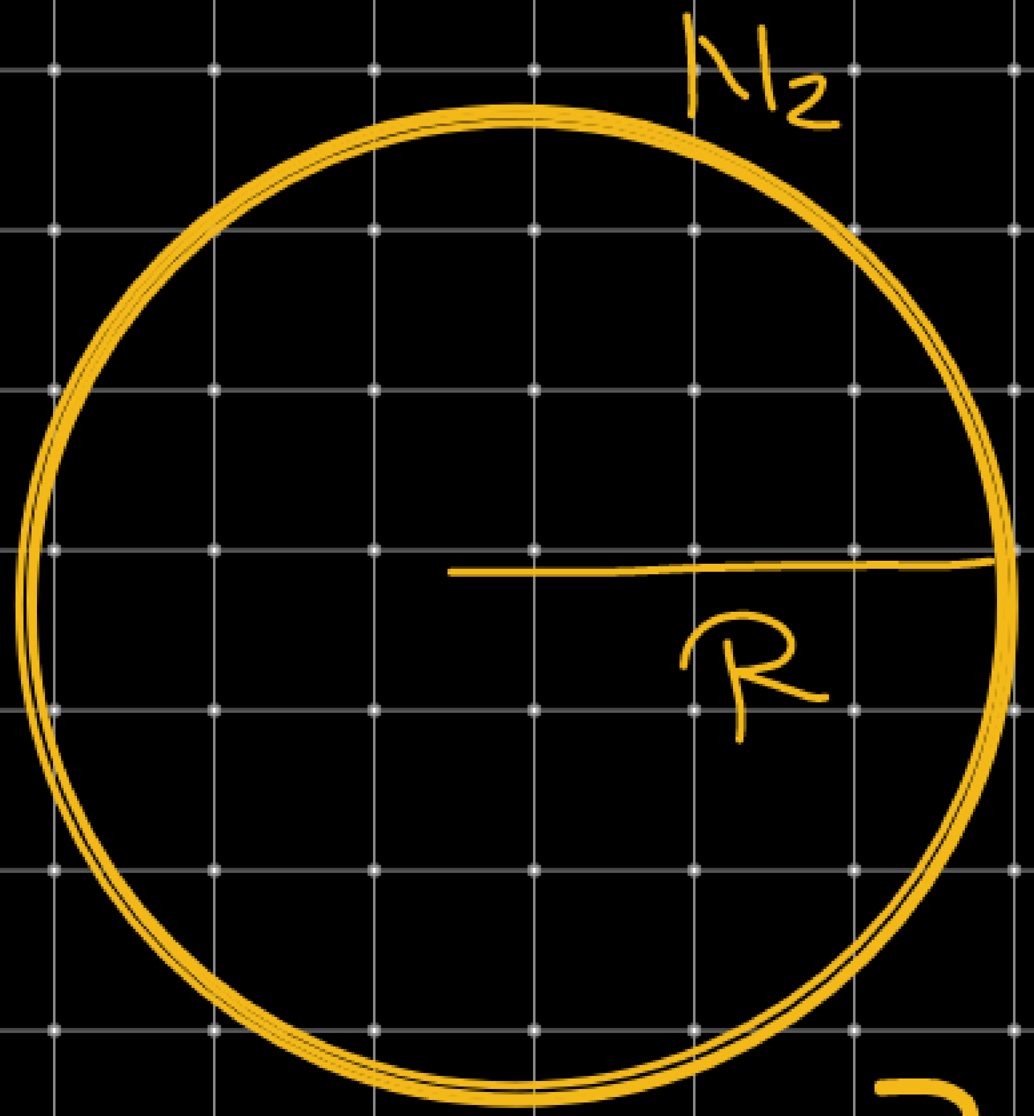
$$\phi_{Total} = 500 \times 10^{-2} = \underline{\underline{5\,Wb}}$$

$$L = \frac{\phi_{total}}{i} = \frac{5}{2} = \underline{\underline{2.5\,H}}$$

Q2) Two circular coil same radius & turns are N_1 & N_2, then find ratio of self inductance.

Sol)





$$L = \frac{\mu_0 \mu_r N^2 \pi R}{2}$$

$$L_1 = \frac{\mu_0 \mu_r N_1^2 \pi R}{2} \qquad L_2 = \frac{\mu_0 \mu_r N_2^2 \pi R}{2}$$

$$\frac{L_1}{L_2} = \frac{N_1^2}{N_2^2}$$

Q) For a solenoid if radius & length of frame both are doubled then effect on self inductance ?

(I) Keeping total turn constant. [good Problem 2-3) min.

(II) Keeping turn density constant.

(I) $l \longrightarrow 2l$ $\quad N = \text{Constant}$

$r \longrightarrow 2r$

$A = \pi r^2 \quad \hookrightarrow 4A$

$$L = \frac{\mu_0 \mu_r N^2 \pi r^2}{l}$$

$$L' = \frac{\mu_0 \mu_r N^2 \pi (2r)^2}{2l} = \frac{\mu_0 \mu_r N^2 \pi \cancel{4}^{2} r^2}{\cancel{2} l} = 2\frac{\mu_0 \mu_r N^2 \pi r^2}{l}$$

$$L' = 2L$$

$$L_{\text{Solenoid}} = \frac{\mu_0 \mu_r N^2 \pi r^2}{l}$$

$$L_{\text{Solenoid}} = \mu_0 \mu_r n^2 \text{ Volume}$$
$$= \mu_0 \mu_r n^2 \pi r^2 l$$

Q) For a solenoid if radius & length of frame both are doubled then effect on self inductance?

(i) Keeping total turn constant.

(ii) Keeping turn density constant.

[good Problem (2-3) min.]

(ii) $r \rightarrow 2r$

$l \rightarrow 2l$

$n \rightarrow$ constant

$$L = \mu_0 \mu_r n^2 \pi r^2 l$$

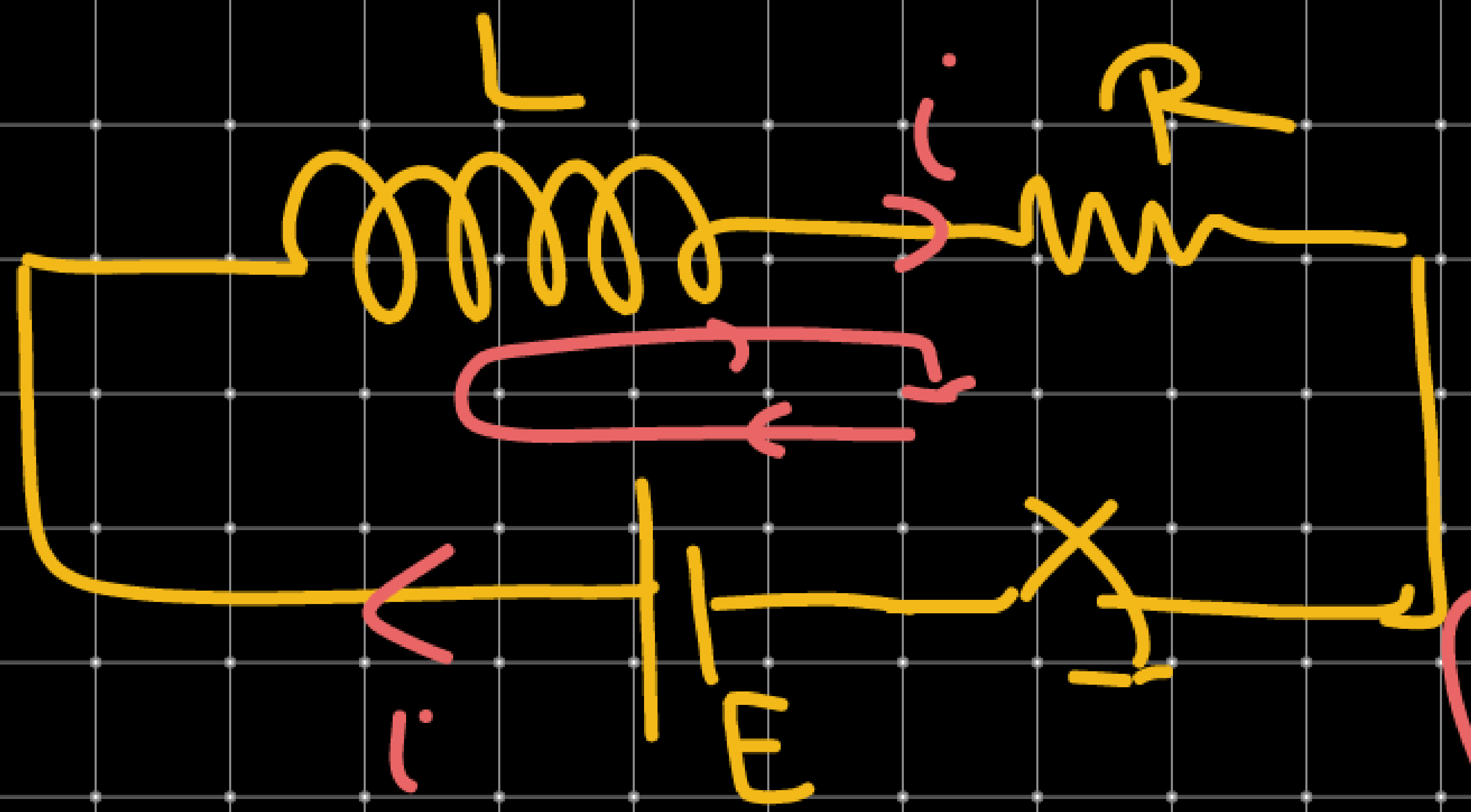
$$L' = \mu_0 \mu_r n^2 \pi (2r)^2 (2l)$$

$$= \mu_0 \mu_r n^2 \pi \times 4r^2 \times 2l$$

$$= 8 \mu_0 \mu_r n^2 \pi r^2 l$$

$$\boxed{L' = 8L}$$

$\Rightarrow$ (L-R) Circuit.



at time t

$$+\mathcal{E} - L\frac{di}{dt} - iR = 0$$

$$\mathcal{E} - iR = L\frac{di}{dt}$$

$$\int \frac{dt}{L} = \int \frac{di}{\mathcal{E} - iR}$$

$$\left(\frac{t}{L}\right)_0^t = \left[\frac{\ln \mathcal{E} - iR}{-R}\right]_0^t$$

$$\left[\frac{t}{L}\right]_0^t = \left[\frac{\ln \varepsilon - iR}{-R}\right]_0^i$$

$$\frac{t}{L} = \frac{\left[\ln \varepsilon - iR\right]_0^i}{-R}$$

$$-\frac{Rt}{L} = \left[\ln \varepsilon - iR - (\ln \varepsilon - 0)\right]$$

$$-t/L/R = \ln\left(\frac{\varepsilon - iR}{\varepsilon}\right)$$

$$e^{-t/\tau} = \frac{\varepsilon - iR}{\varepsilon}$$

$$-\frac{tR}{L} = -t/L/R$$

$$L/R = \tau$$

$\Downarrow$

Time Constant

$$\varepsilon - iR = \varepsilon e^{-t/\tau}$$

$$\varepsilon - \varepsilon e^{-t/\tau} = iR$$

$$\frac{\varepsilon - \varepsilon e^{-t/\tau}}{R} = i$$

$$\frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right) = i$$

$$\boxed{i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)}$$

$$i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$$

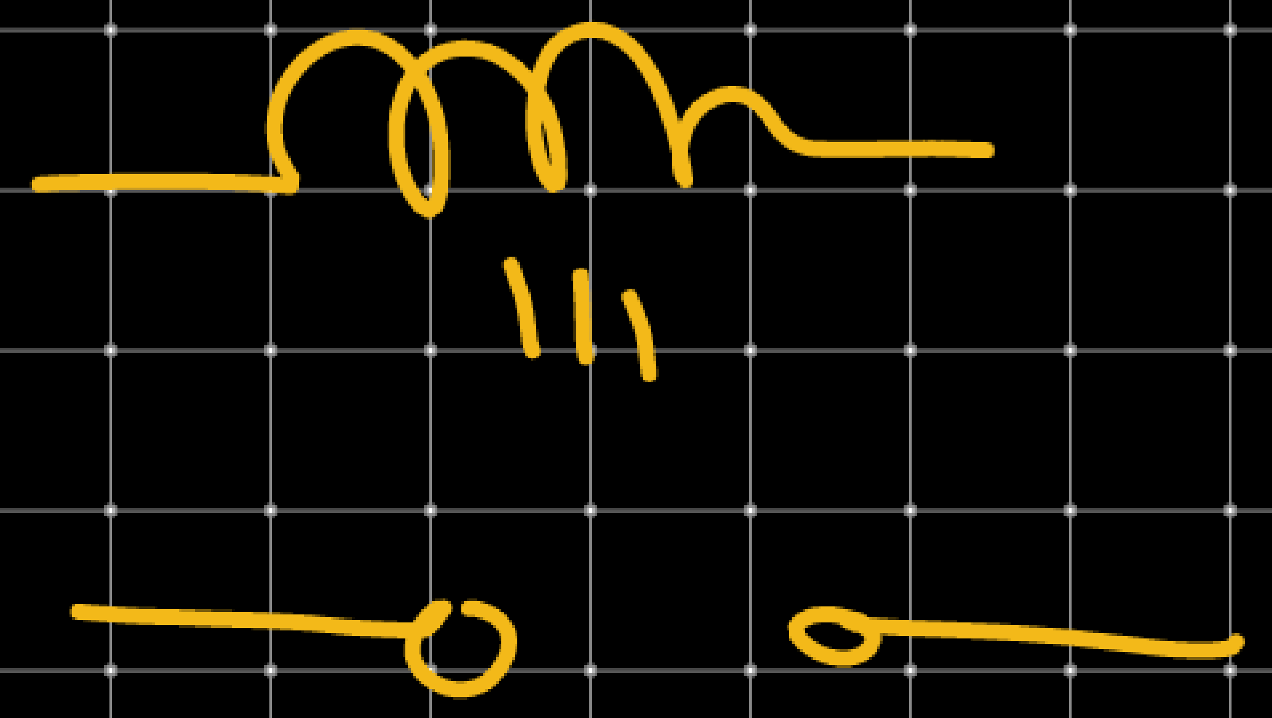
$$i = \frac{\varepsilon}{R}\left(1 - \frac{1}{e^{t/\tau}}\right)$$

$\underline{t=0}$

$$i = \frac{\varepsilon}{R}\left(1 - \frac{1}{e^{0}}\right)$$

$$i = \frac{\varepsilon}{R}\left(1 - \frac{1}{1}\right) = \underline{0}$$

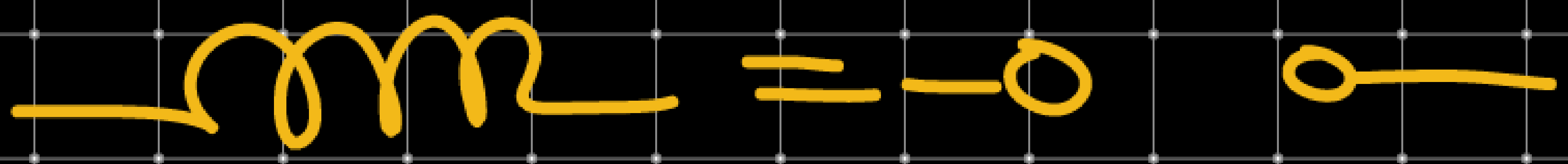
$t=0 \quad i=0$



$$i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$$

$$\boxed{\tau = \frac{L}{R} = \text{Time Constant}}$$

$t = 0 \quad i = 0$



$t = \infty \quad i = \frac{\varepsilon}{R}$

$t = \infty$

$$i = \frac{\varepsilon}{R}\left(1 - \frac{1}{e^{t/\tau}}\right)$$

$$i = \frac{\varepsilon}{R}\left(1 - \frac{1}{e^{\infty}}\right)$$

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

$$= \frac{\varepsilon}{R}(1 - 0)$$

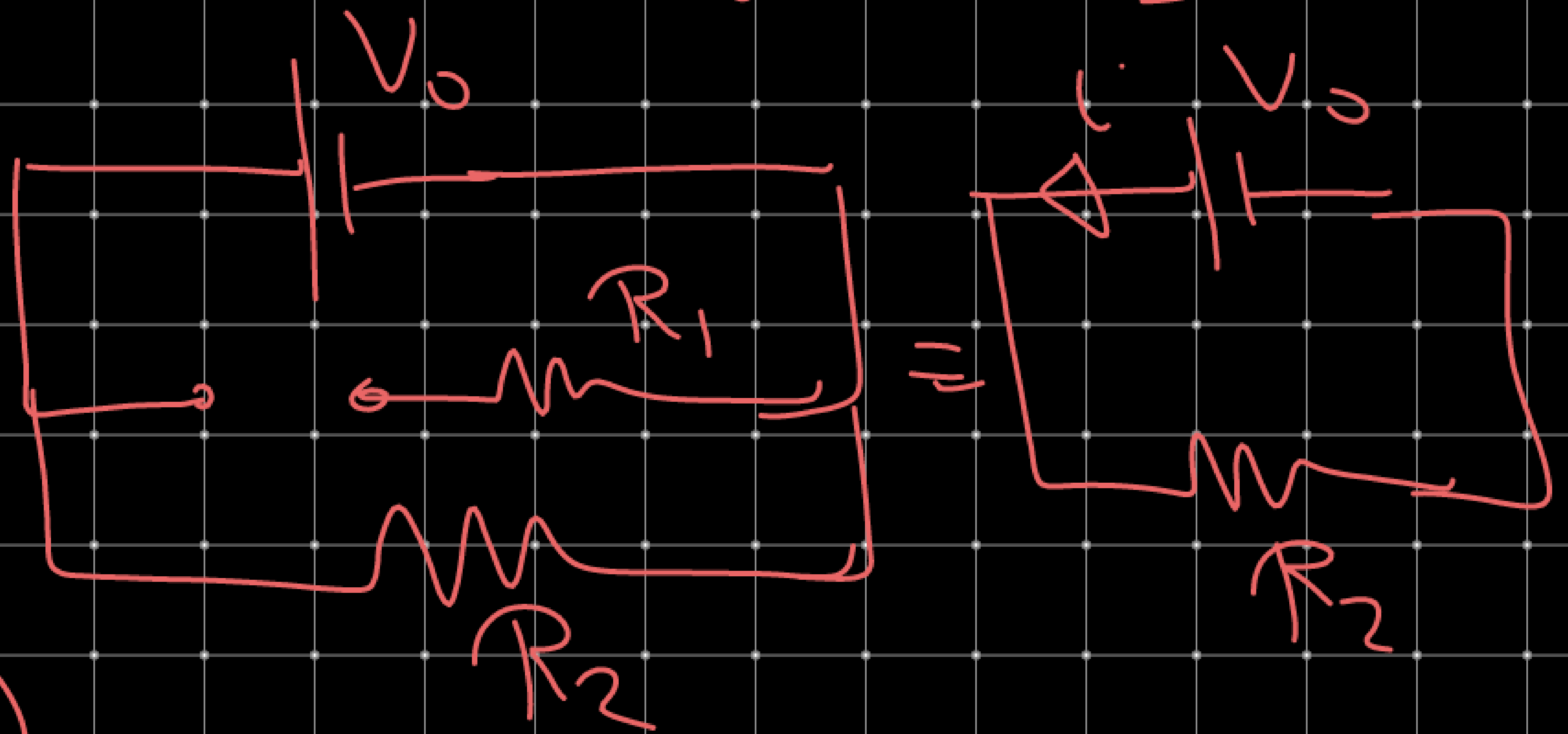
$$i = \frac{\varepsilon}{R}$$

Q) If swith is on at $t=0$. find current in ckt.

(i) $t=0$ (ii) $t=\infty$

(i) $t=0$

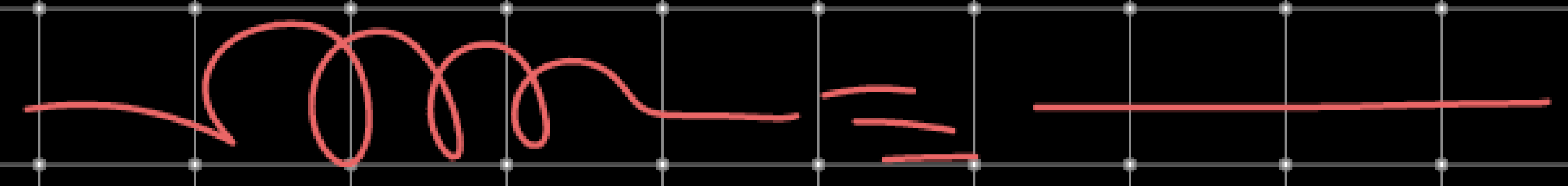
$$i = \frac{V_0}{R_2}$$

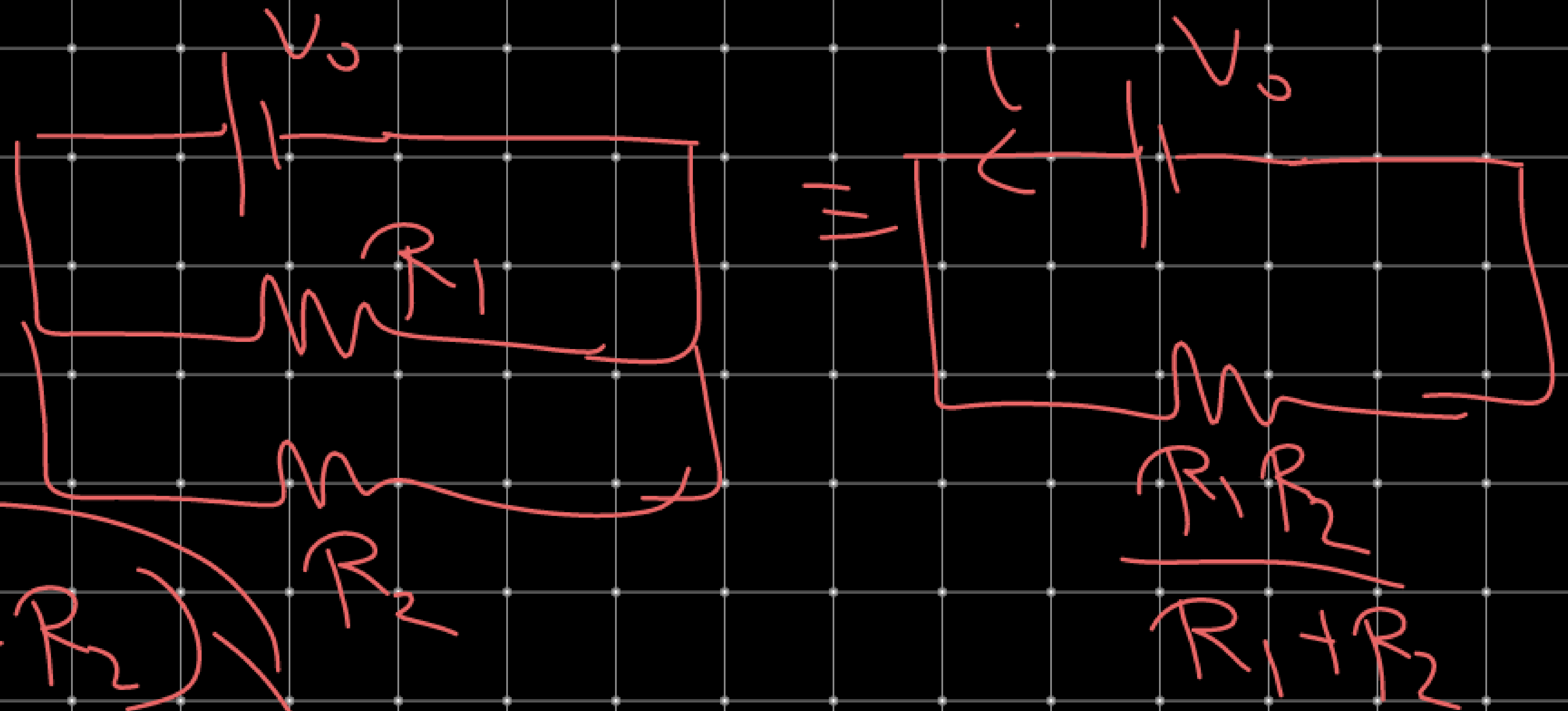


Q) If swith is on at $t=0$. find current in ckt:

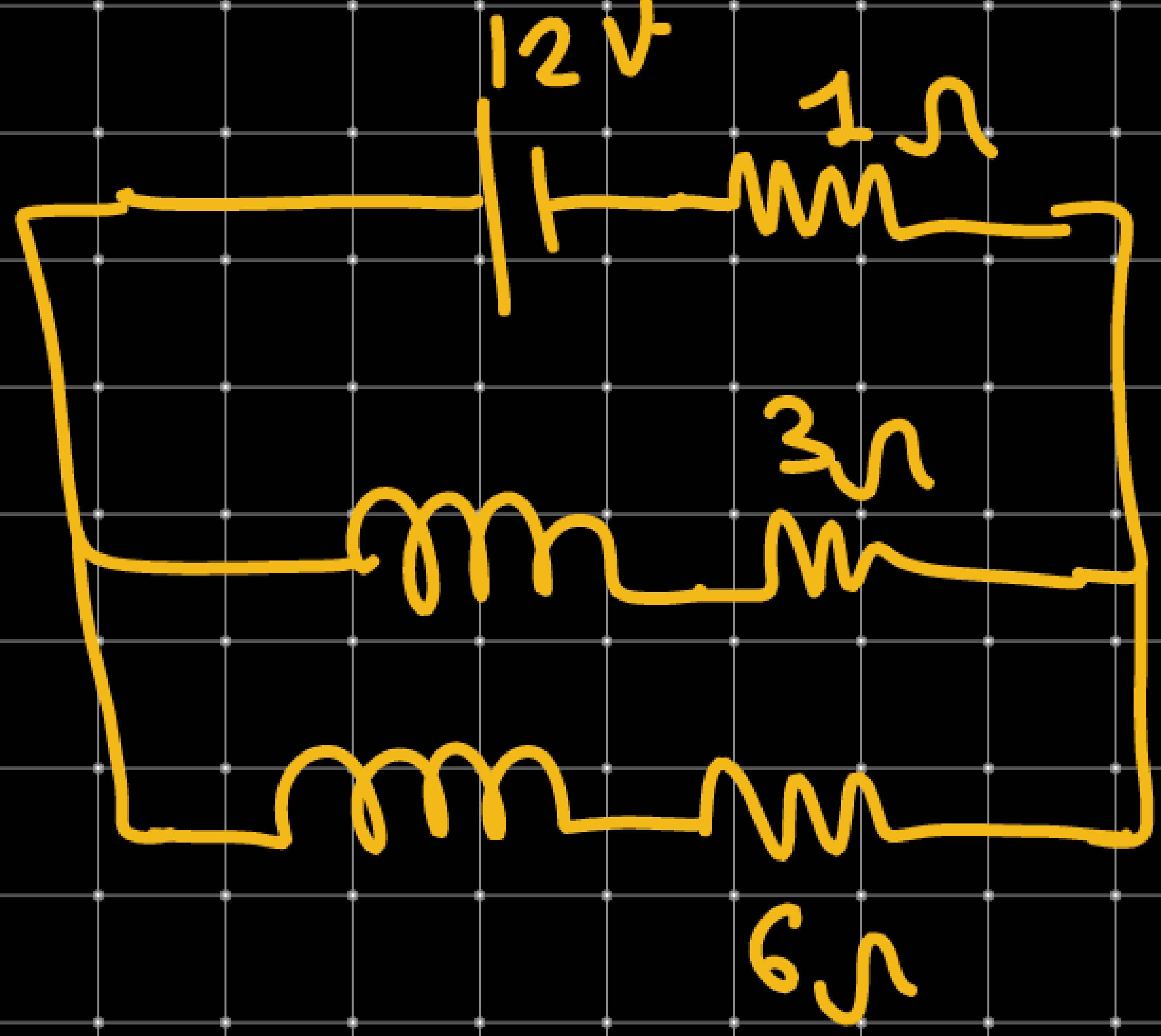
(i) $t=0$ (ii) $t=\infty$

(ii) $t=\infty$

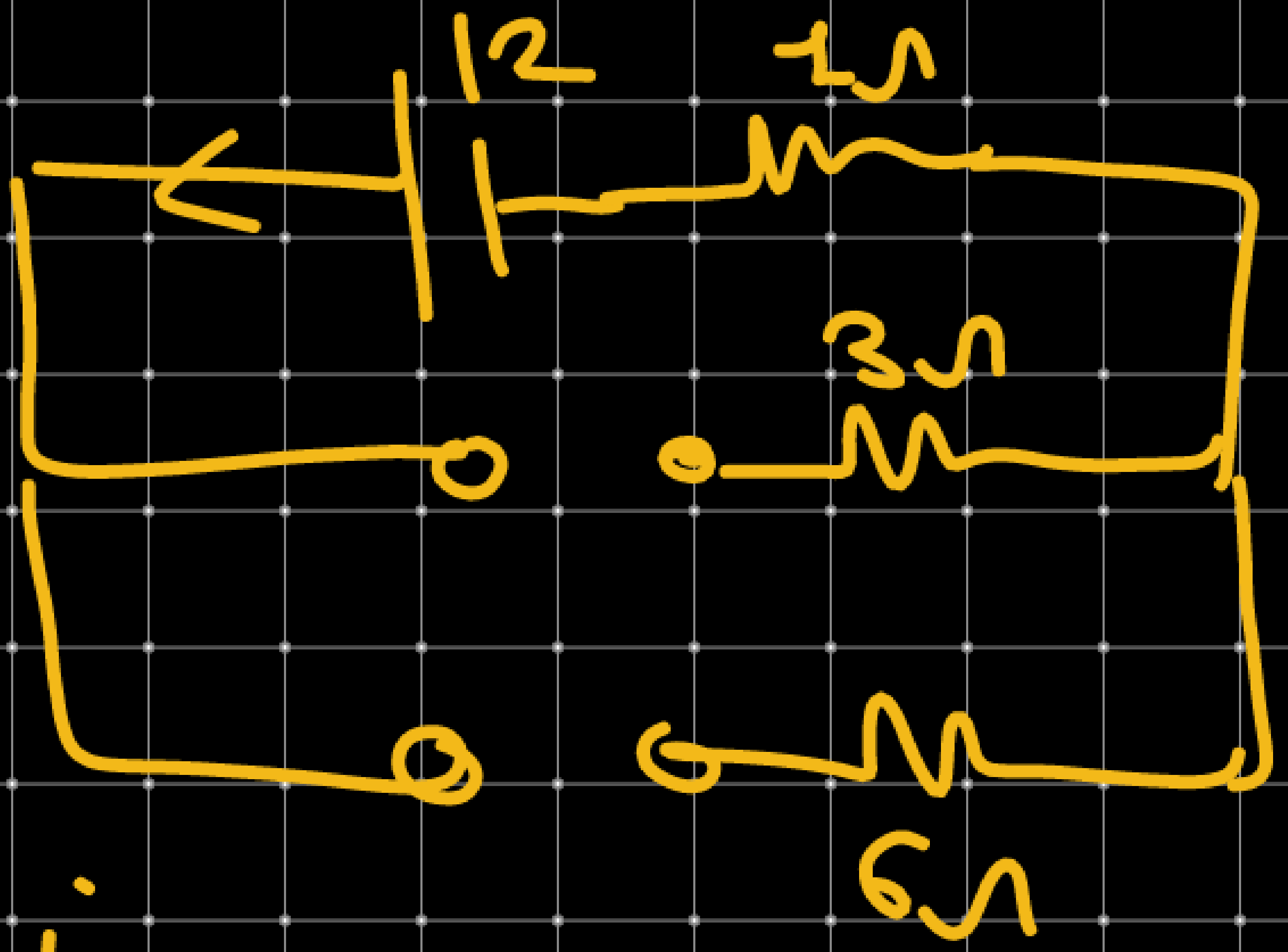




$$i = \frac{V_0}{\frac{R_1R_2}{R_1+R_2}} = \frac{V_0(R_1+R_2)}{R_1R_2}$$

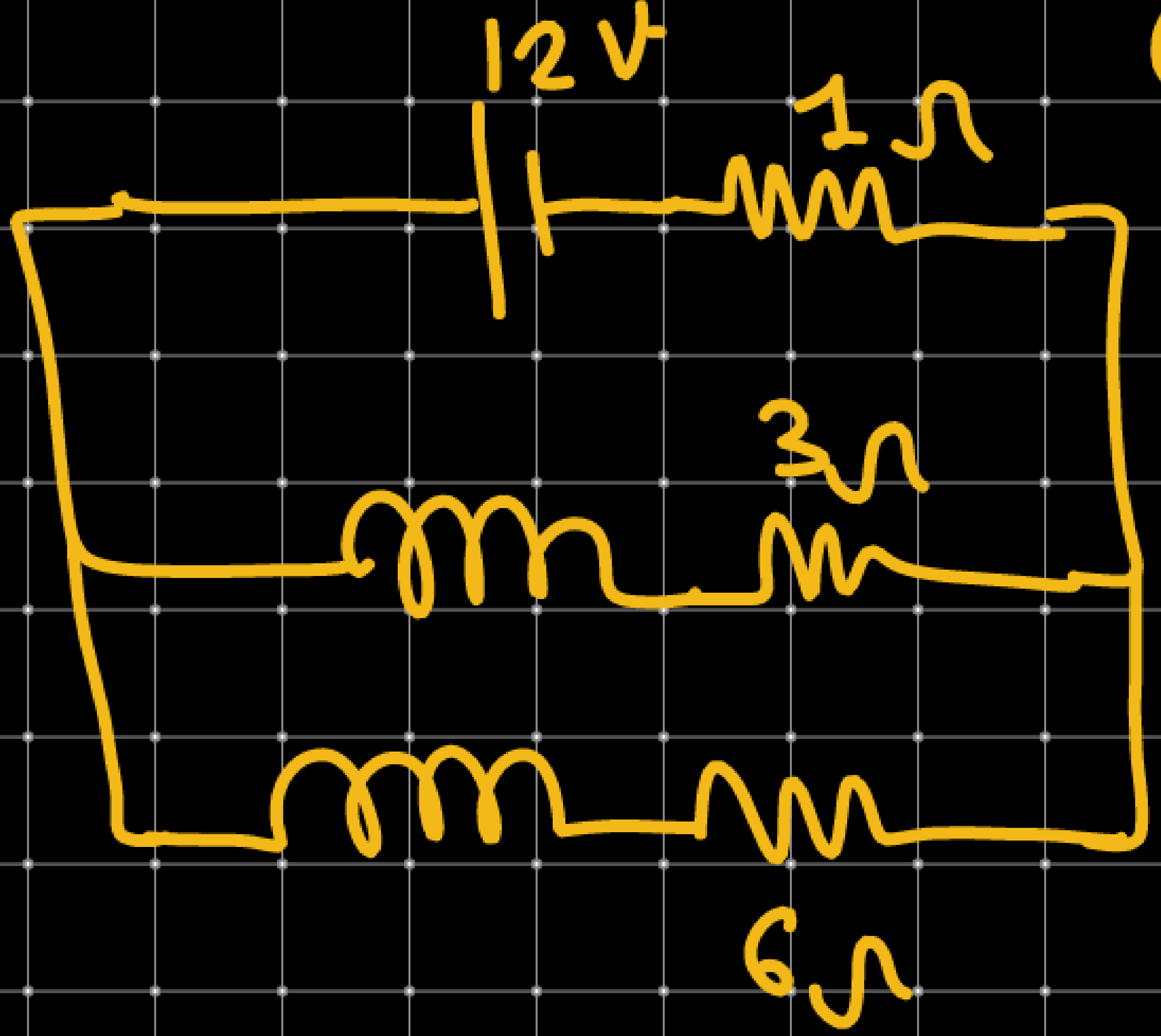


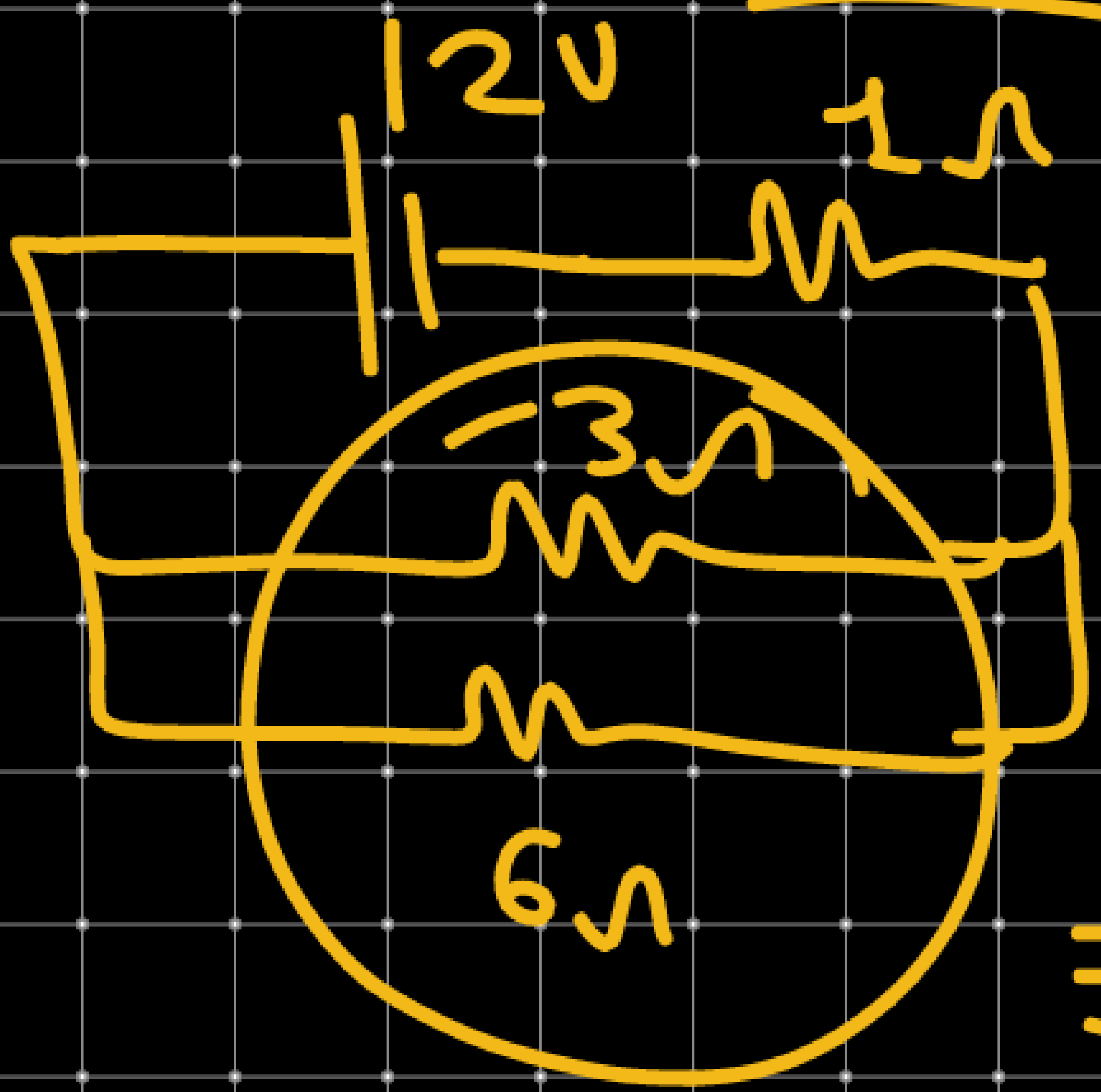
(a) $t = 0 \quad i = ?$



$i = 0$

① $t = \infty$ $\quad$ $i = ?$





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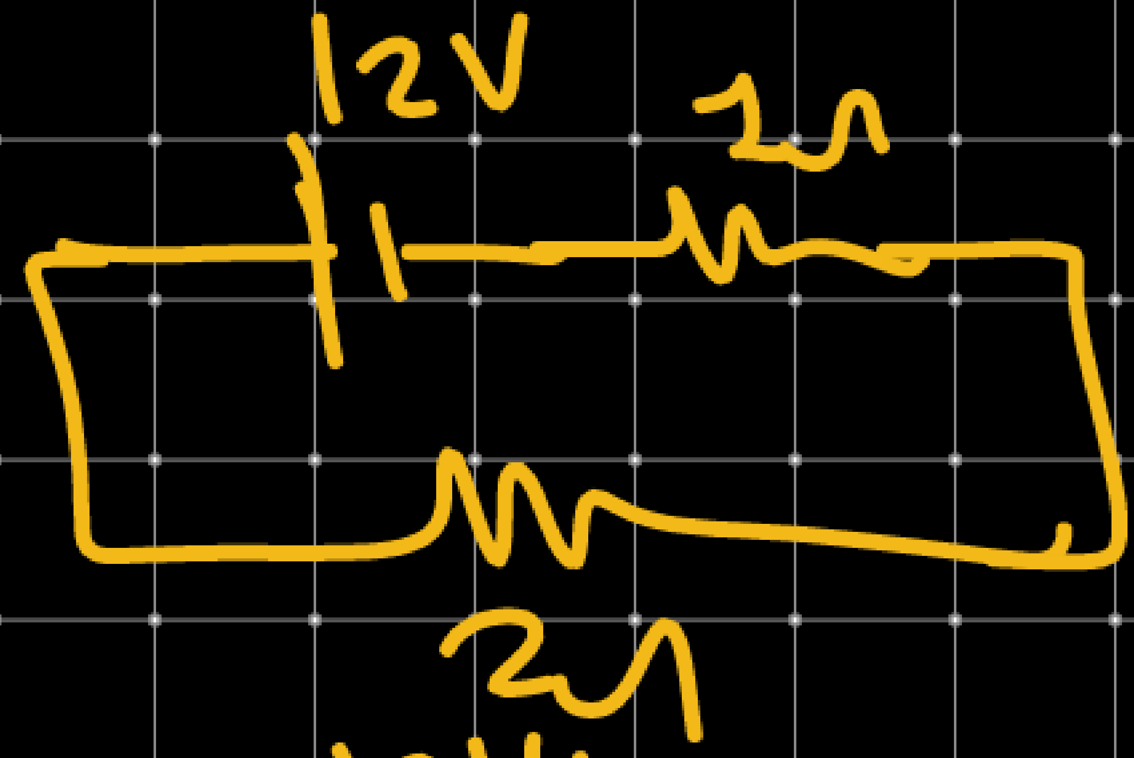


$\equiv$

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{3 \times 6}{9}$$

$$= 2\Omega$$

$$i = \frac{12}{3}$$

$$i = 4\ \text{Amp}$$

$$\boxed{\text{In L-R Circuit}}$$

$$i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$$

$t = 0$, $i = 0$

$t = \infty$ $\quad i = \frac{\varepsilon}{R}$

$t = 1\tau$ time constant

$$i = \frac{\varepsilon}{R}\left(1 - e^{-\tau/\tau}\right) = \frac{\varepsilon}{R}\left(1 - e^{-1}\right) = \frac{\varepsilon}{R}\left(1 - \frac{1}{e}\right) = \frac{\varepsilon}{R}\left(1 - 0.37\right)$$

$$i = 0.63\frac{\varepsilon}{R}$$

Imp – τ = Time constant

$$\tau = \frac{L}{R}$$

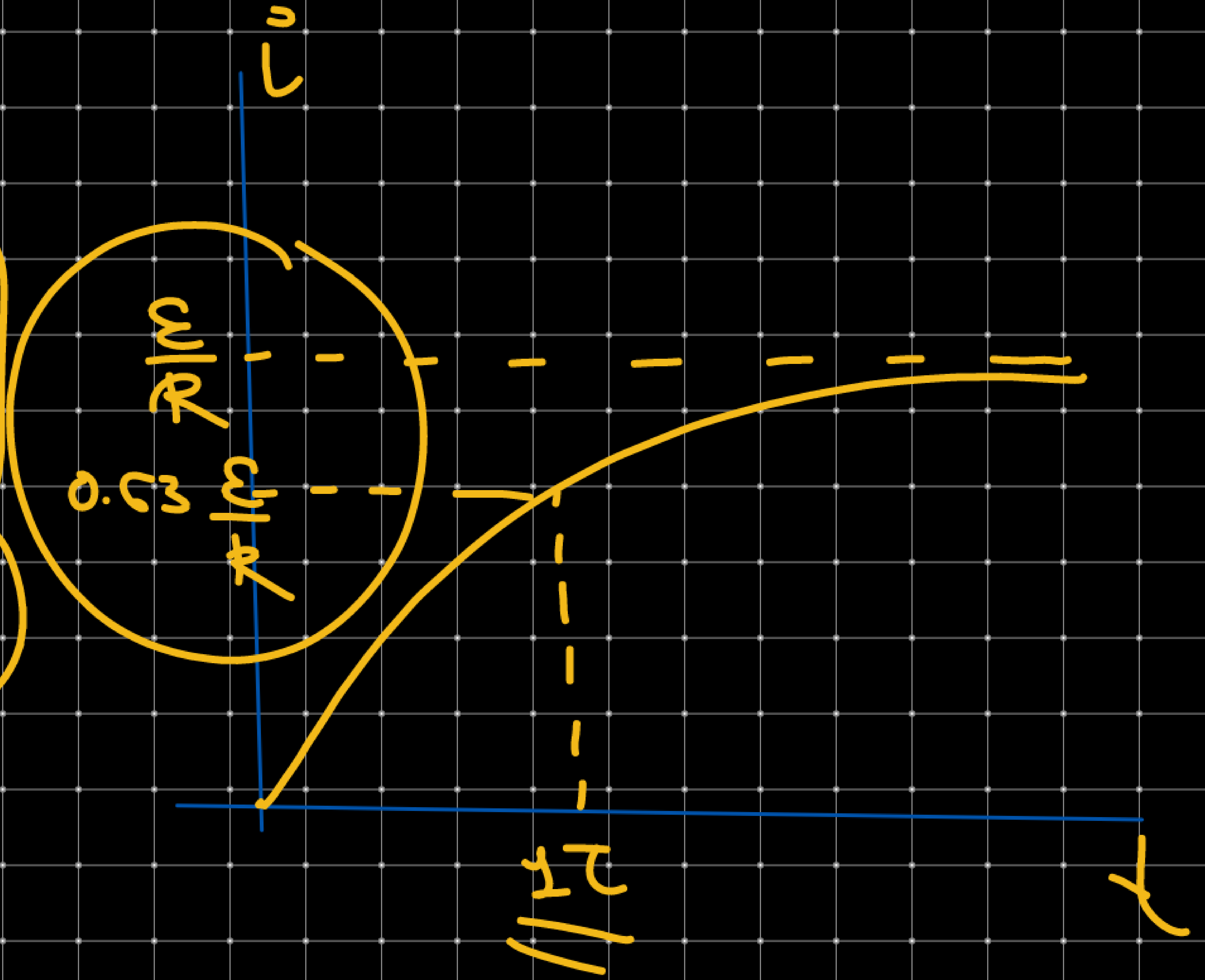
$$\left[\frac{L}{R}\right] = [T]$$

$$\left(\frac{1}{e} = 0.37\right)$$

$$\boxed{t = 1\tau =}$$

$$\boxed{i = 0.63\,\frac{\varepsilon}{R}}$$

$$i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$$



$$\int \frac{dx}{a+bx} = \frac{\ln(a+bx)}{b}$$

$$\int \frac{dx}{a-bx} = \frac{\ln(a-bx)}{-b}$$