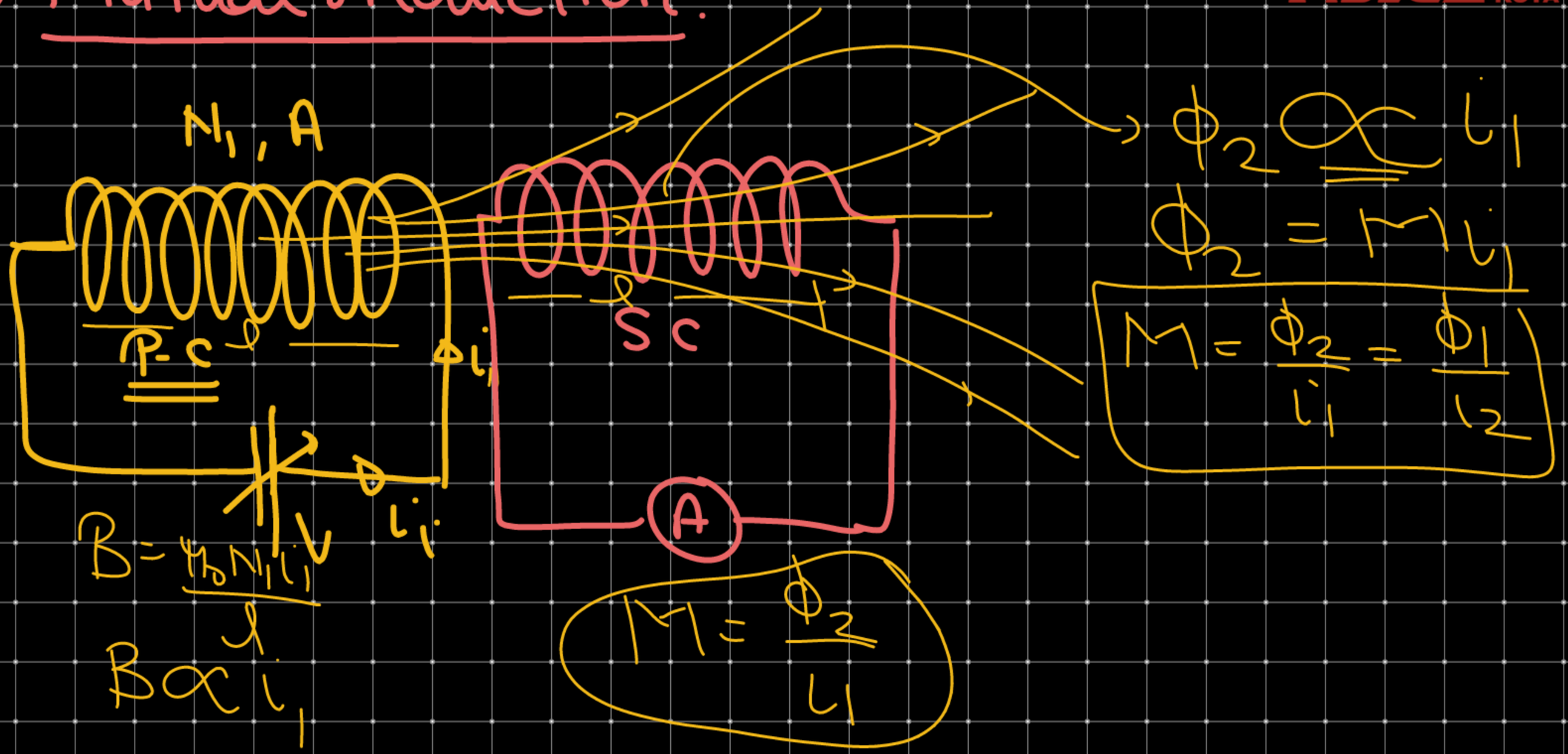
Mutual Induction :-



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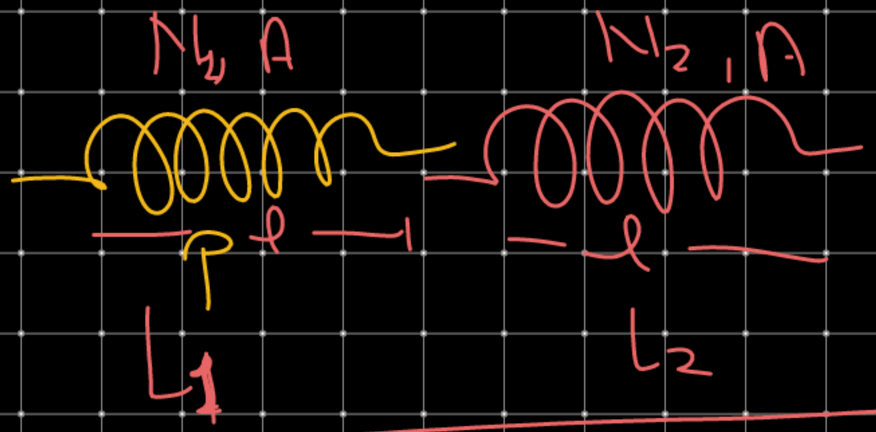
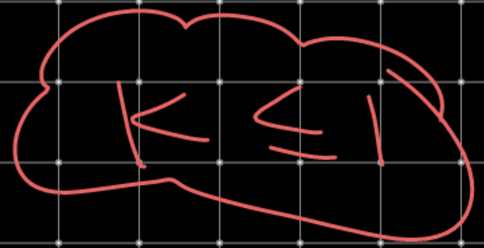
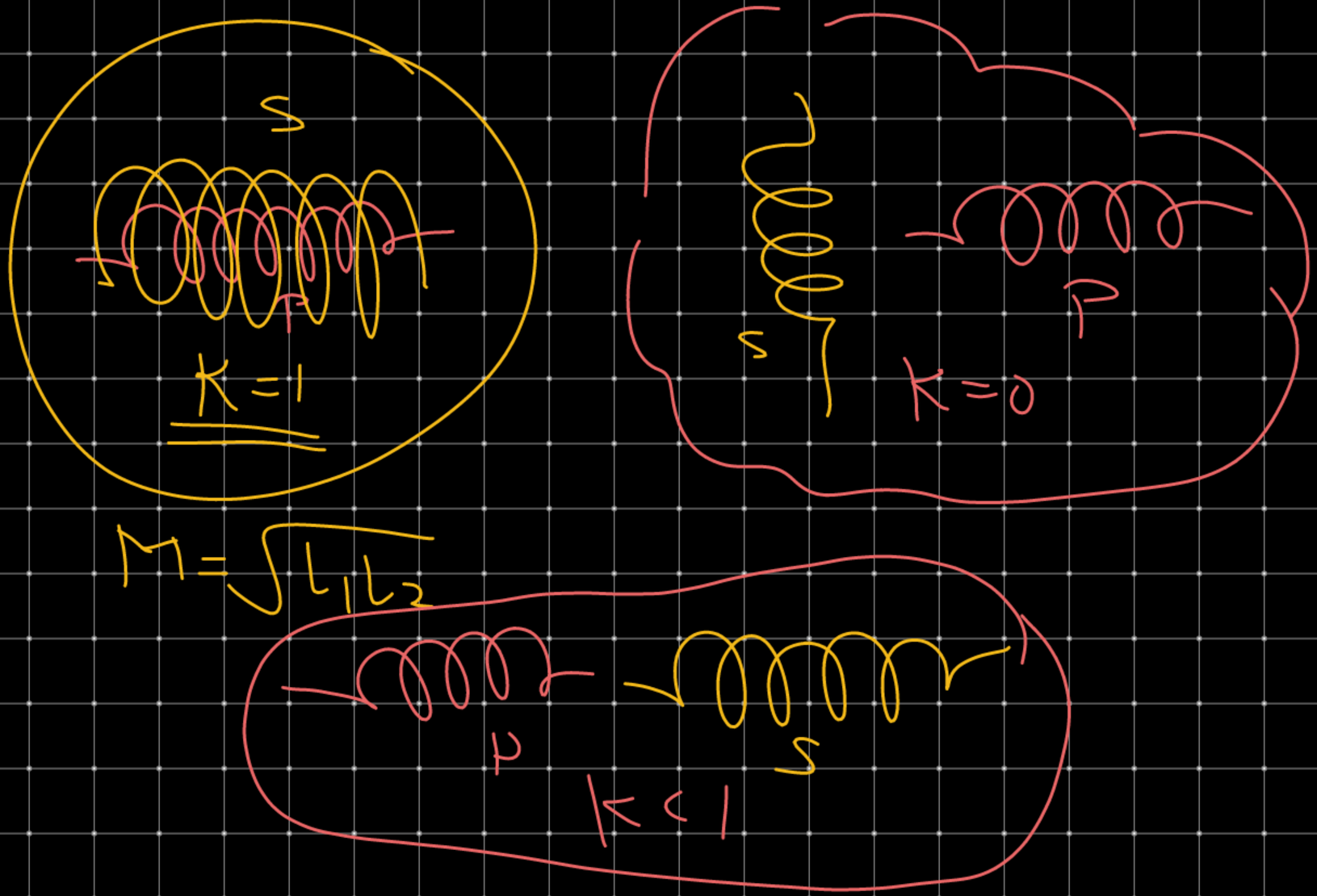


$$M = K\sqrt{L_1 L_2}$$

K = Coupling factor

$K = 1$




S
P
K=1
S
P
K=0
M=√L1L2
P
S
K<1

Question based on Mutual Induction

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Q1: Current in primary coil is 5 amp & flux in secondary coil is 20 Wb. Then find mutual induction.

Sol) $i_p = 5\,\text{Amp} = i_1$

$\phi_2 = 20\,\text{Wb}$

$$M = \frac{\phi_2}{i_1} = \frac{20}{5} = 4\,H$$

$$M = \frac{\phi_2}{i_1}$$

$$M = \frac{\phi_1}{i_2}$$

Q2) $L_1 = 2mH$, $L_2 = 8mH$, $K = 90\%$

$M = ?$

$K = 0.9$

$M = K\sqrt{L_1 L_2}$

$M = 0.9\sqrt{2 \times 8 m^2H^2}$

$= 0.9\sqrt{16 m^2H^2}$

$= 0.9 \times 4 mH$

$M = 1.6 mH$

$M = 1.6 \times 10^{-3} H$

$K = 1$, 100%

$M = K\sqrt{L_1 L_2}$

$M = \sqrt{L_1 L_2}$

$K = 1$

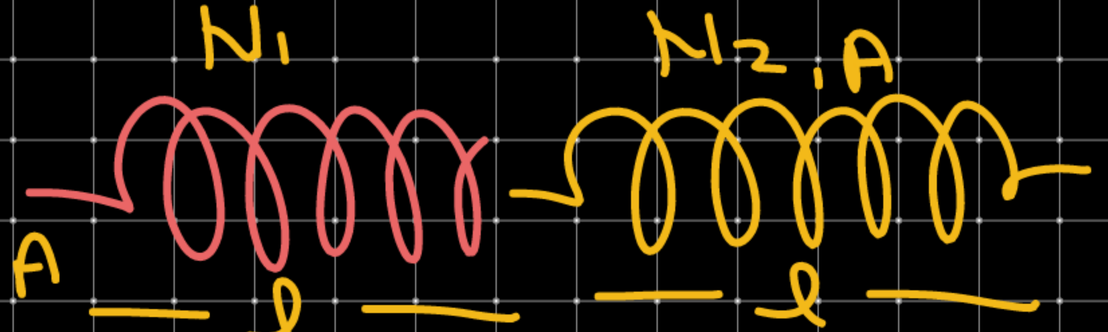
Q3) two Solenoid having turns N_1 & N_2 are wound on same frame (A, l) then

$M = ?$

$$M = \sqrt{L_1 L_2}$$

$$M = \sqrt{\left(\frac{\mu_0 N_1^2 A}{l}\right)\left(\frac{\mu_0 N_2^2 A}{l}\right)}$$

$$\boxed{M = \frac{\mu_0 N_1 N_2 A}{l}}$$



$$L_1 = \frac{\mu_0 N_1^2 A}{l}$$

$$L_2 = \frac{\mu_0 N_2^2 A}{l}$$

Formula Chart

⇒ Short Notes

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Q4) If Primary current changes from 10 Amp to 5A in 0.1 sec. then induced Emf in secondary coil is 50mV. find M.

Sol)

$$\frac{\Delta i_1}{\Delta t} = \frac{(5-10)}{0.1} = \frac{-5}{0.1} = -50\,A/sec.$$

$$\varepsilon_{ind} = -M\frac{di_1}{dt}$$

$$\varepsilon_{ind} = -M(-50)$$

$$50\times10^{-3}\,V = 50M$$

$$1H = 1\,\omega b/A$$

$$\boxed{M = 10^{-3}\,H}$$

Hint

$$\phi_2 = Mi_1$$

$$\varepsilon_{ind} = \frac{-d\phi_2}{dt} = -M\frac{di_1}{dt}$$

$$M = \frac{\phi_2}{i_1}$$

Q5) $I_1 = 2\sin 100\pi t$.

$M = 10^{-2}\ H$, find E_{max} = ?

$$M = \frac{\phi_2}{i_1} = \frac{\phi_1}{i_2}$$

Sol) $\phi_2 = M I_1$

$\phi_2 = 10^{-2}\left[2\sin 100\pi t\right)$

$\phi_2 = 2\times 10^{-2}\sin 100\pi t$

$\varepsilon_{ind} = -\frac{d(2\times 10^{-2}\sin 100\pi t)}{dt}$

$= -\left[2\times 10^{-2}\cos 100\pi t \times 100\pi\right)$

$\varepsilon_{ind} = -2\times 10^{-2}\times 100\pi\times(\cos 100\pi t)$

$\varepsilon_{ind} = -2\pi\cos 100\pi t$

$\varepsilon_{ind} = -2\pi \times -1$

$\varepsilon_{ind} = 2\pi\ Volt$

$(-1 \quad 1)$

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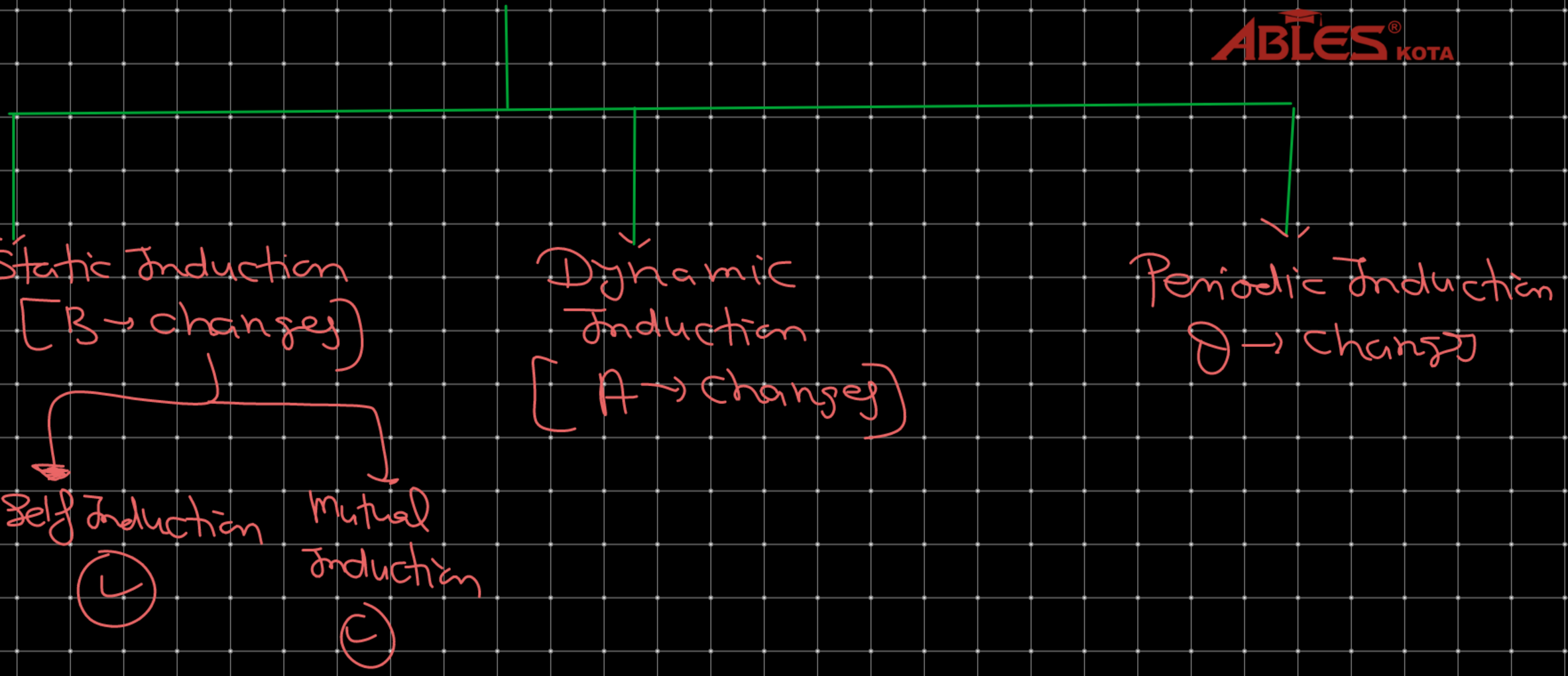
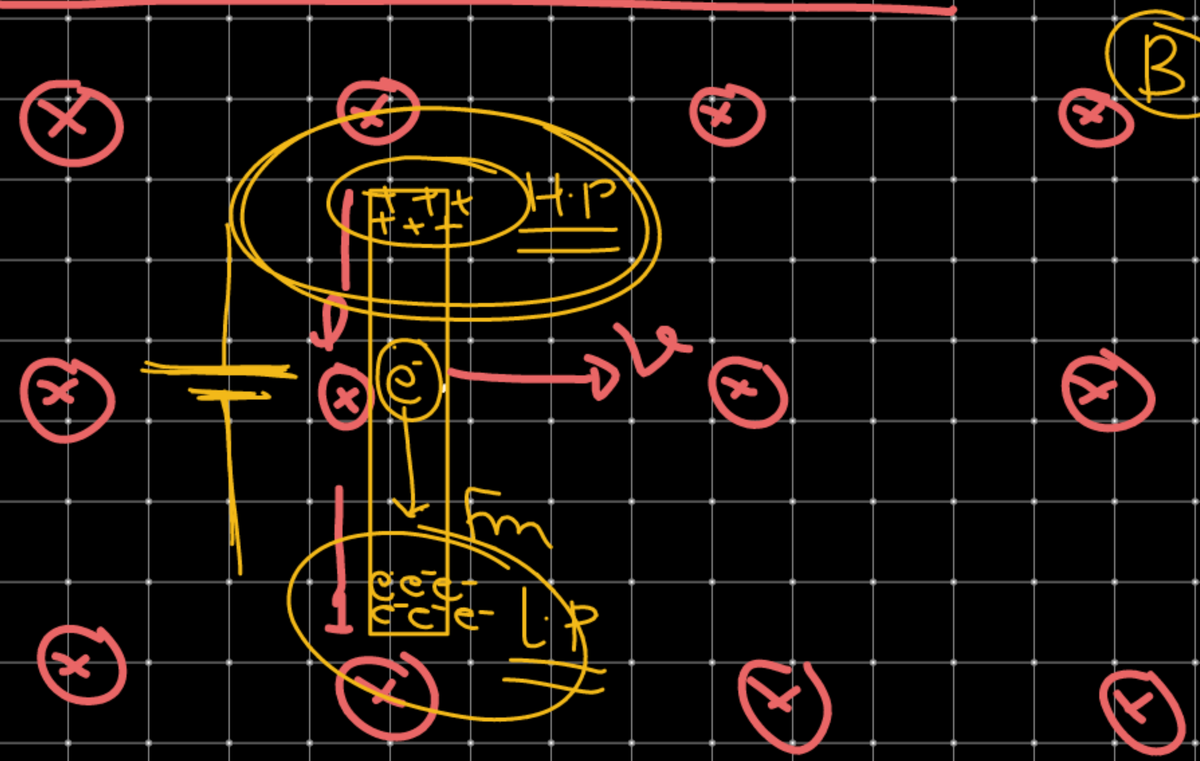

Static Induction
[B → changes]
Self Induction
(L)
Mutual Induction
(M)
Dynamic Induction
[A → changes]
Periodic Induction
[θ → changes]

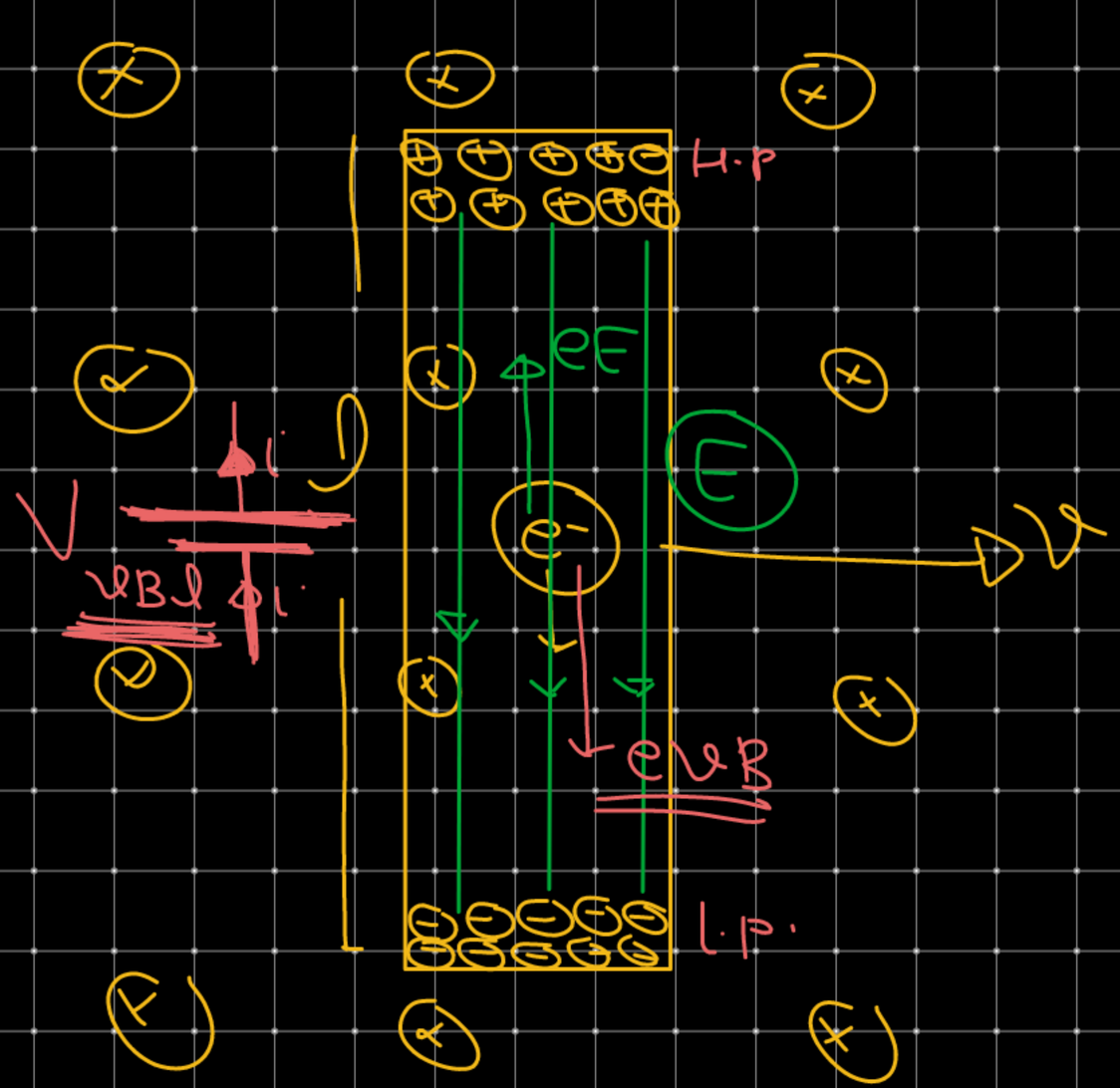
⇒ Motional Induction :-



B

$$V = BIl$$

$$\vec{F}_m = q[\vec{v} \times \vec{B}]$$



$F = qvB$

$F_m = evB$

$F_e = eE$

At Equilibrium Condition

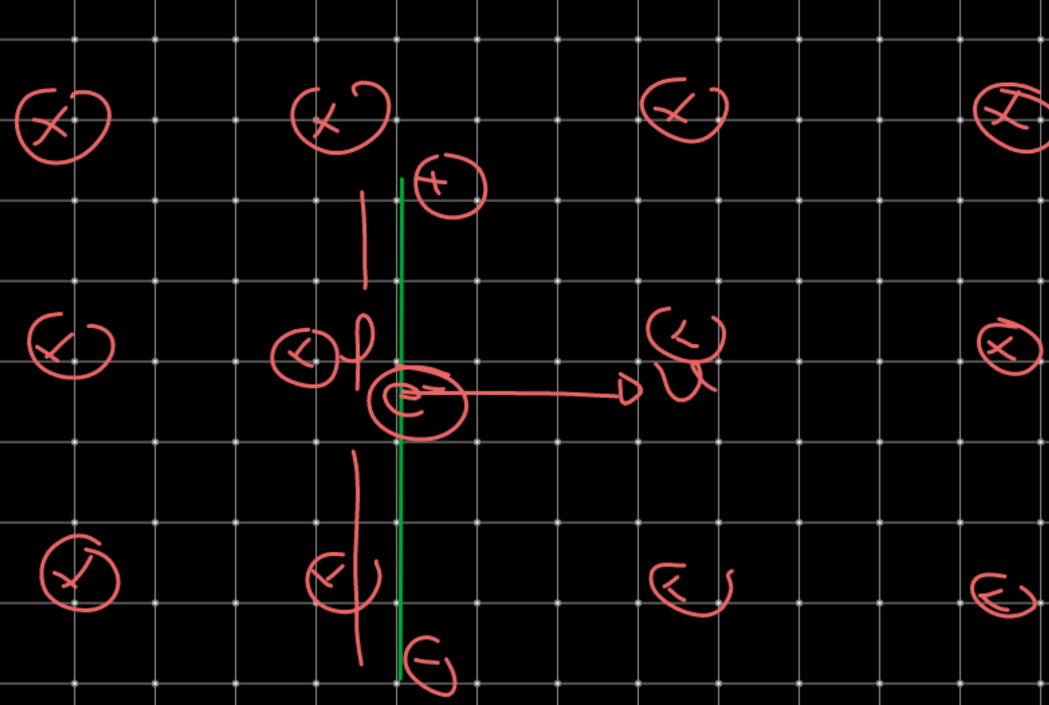
$eE = evB$

$E = vB$

$V = \mathcal{E}_m = El$

$= vBl$

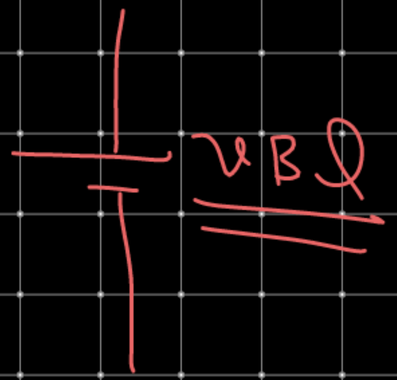
Motional Emf of rod in m.f.



B

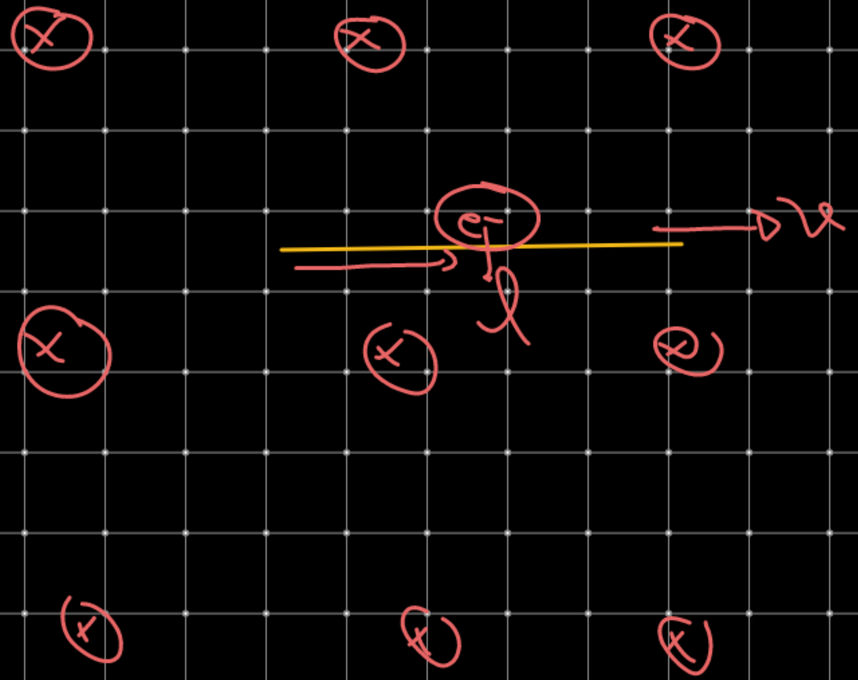
$v l B l$

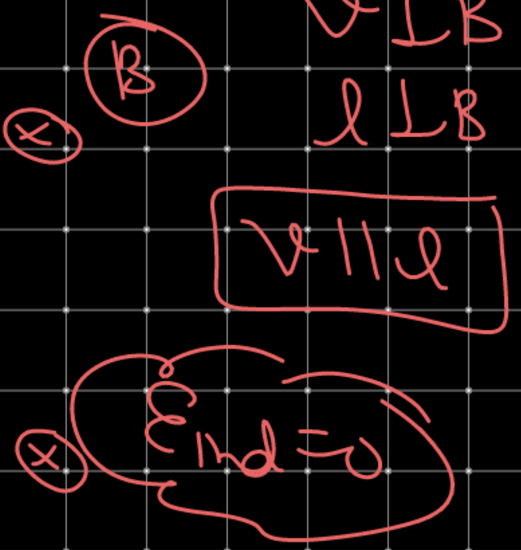
$\equiv$

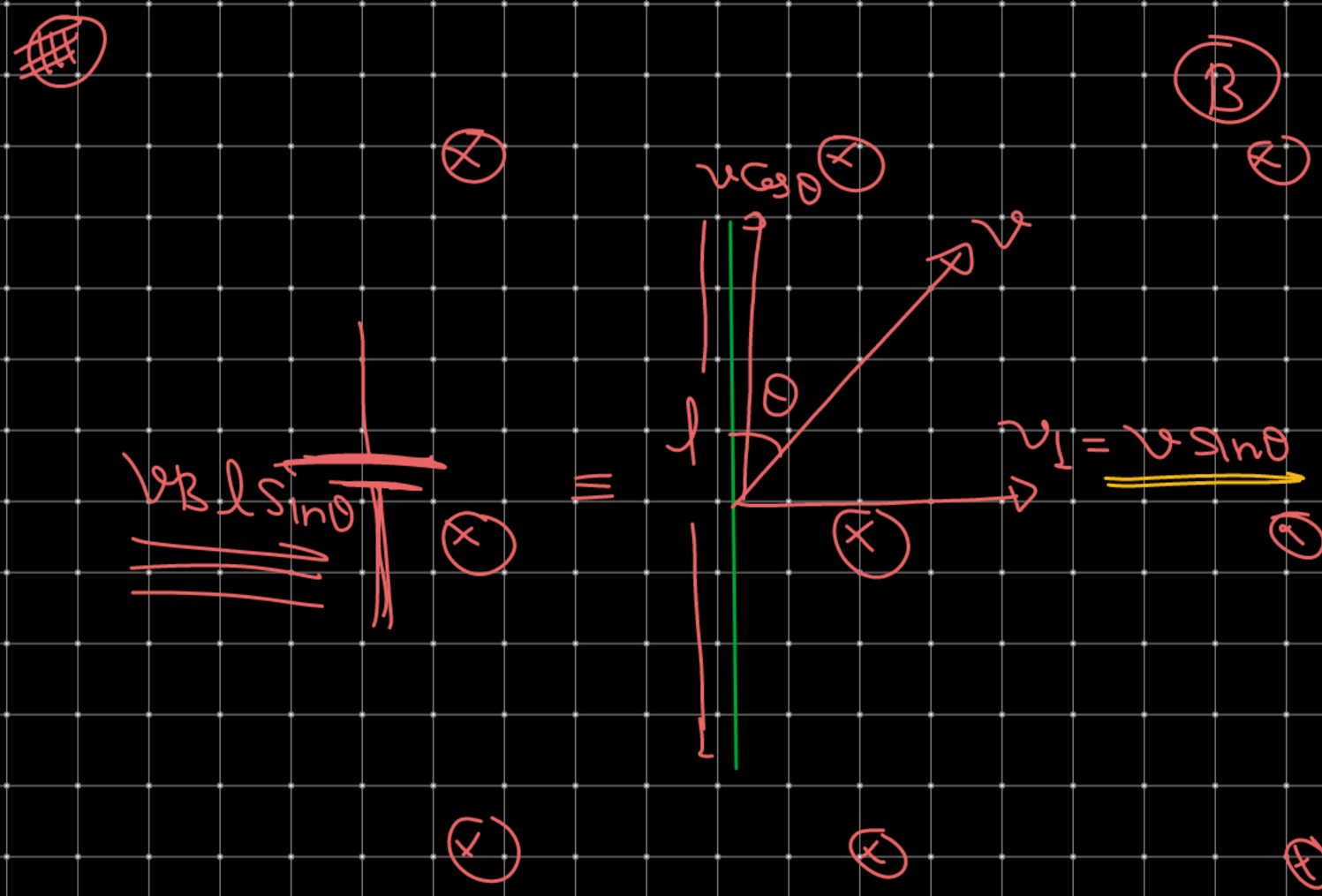


vBl

(#) If any two Physical quantity Parallel to each other then $\mathcal{E}_{motion} = 0$







$\vec{B} \perp \vec{l}$

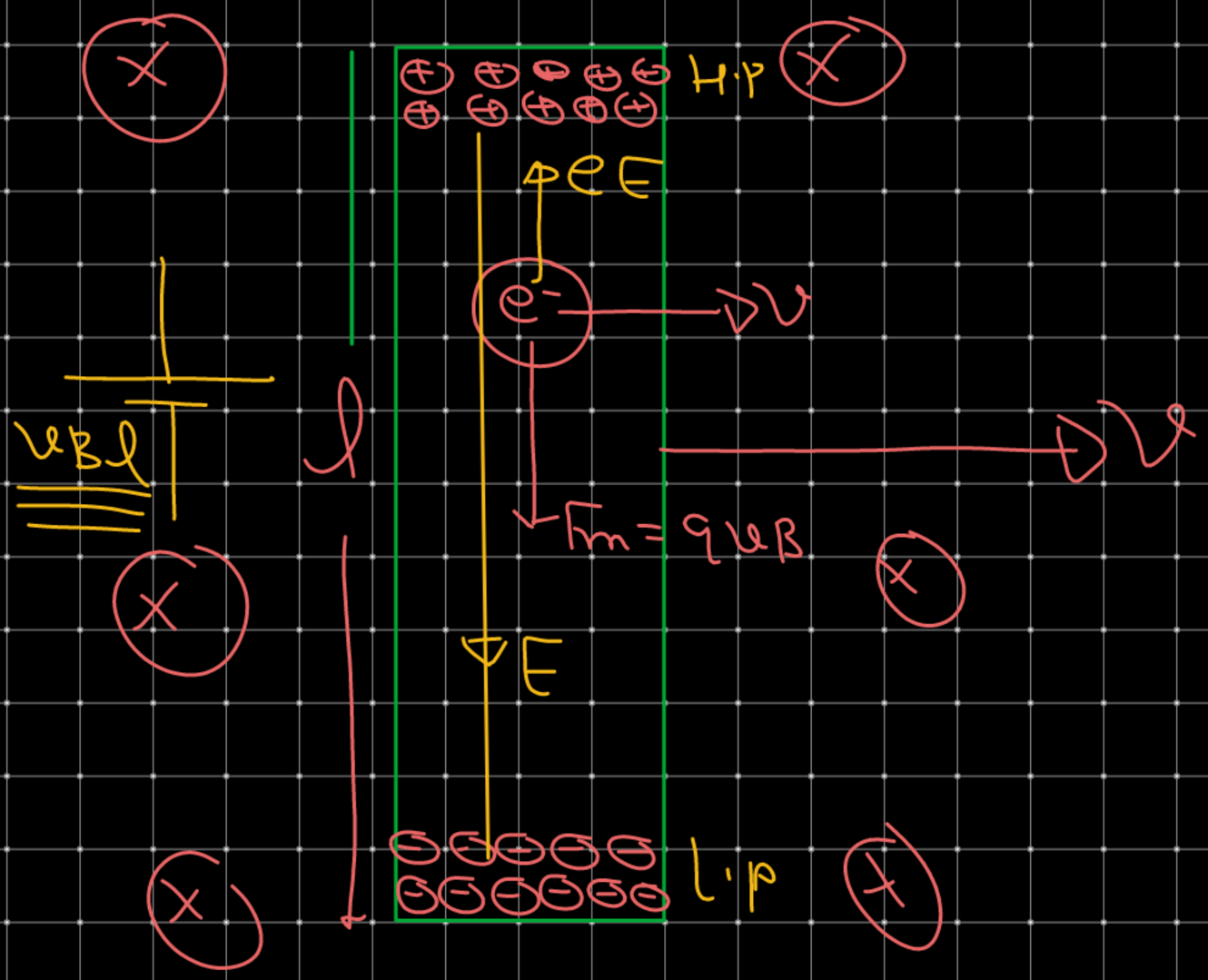
$\vec{B} \perp \vec{v}$

$v \perp \neq l$

$v \sin\theta$

$\varepsilon_{ind} = (v\sin\theta) B l$

$= vBl\sin\theta$



$$\vec{F}_m = q(\vec{v} \times \vec{B})$$

At Equilibrium

$$eE = evB$$

$$E = vB$$

$$\Delta V = E \times l$$

$$\varepsilon_{instt} = vB \times l$$

$$\varepsilon_i = vBl$$

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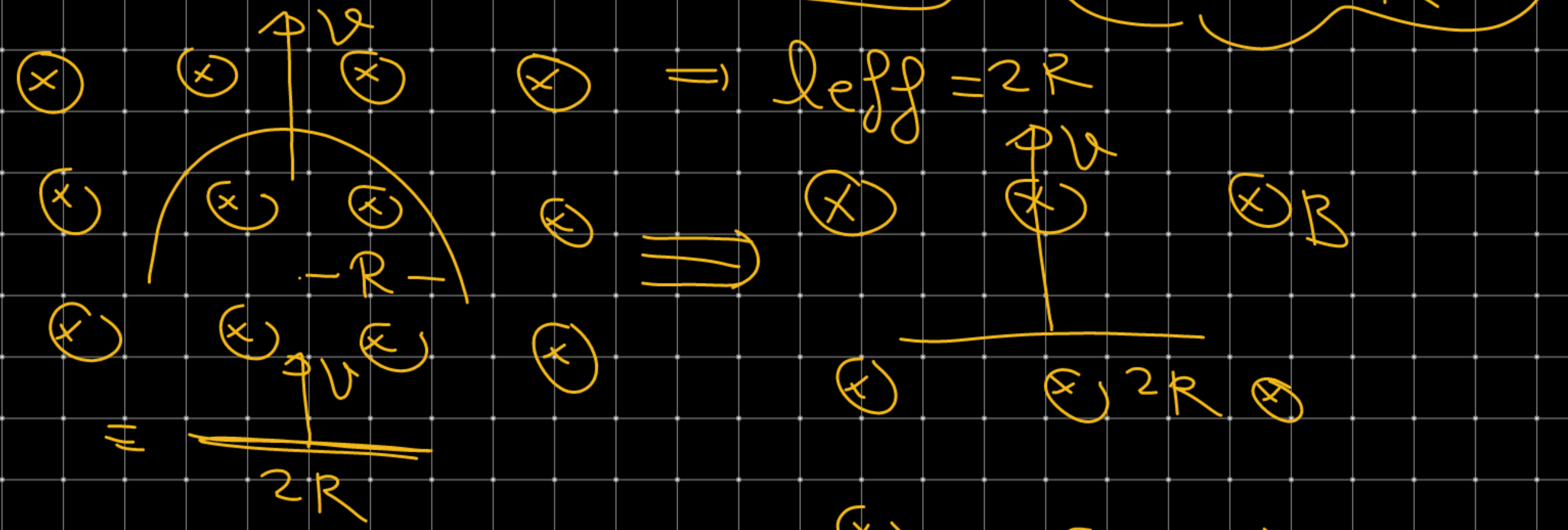
(#)

$$\mathcal{E}_{motion} = v_1 l_1 B_1$$

$\mathcal{E} = vB(2R)$

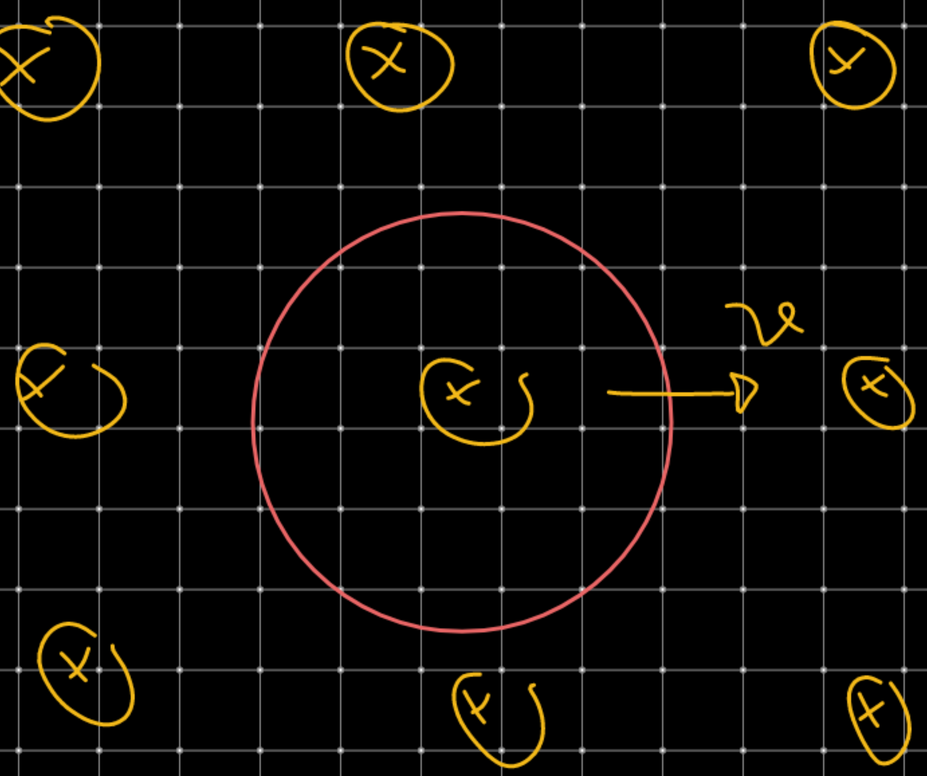
$\mathcal{E} = 2vBR$

(#)

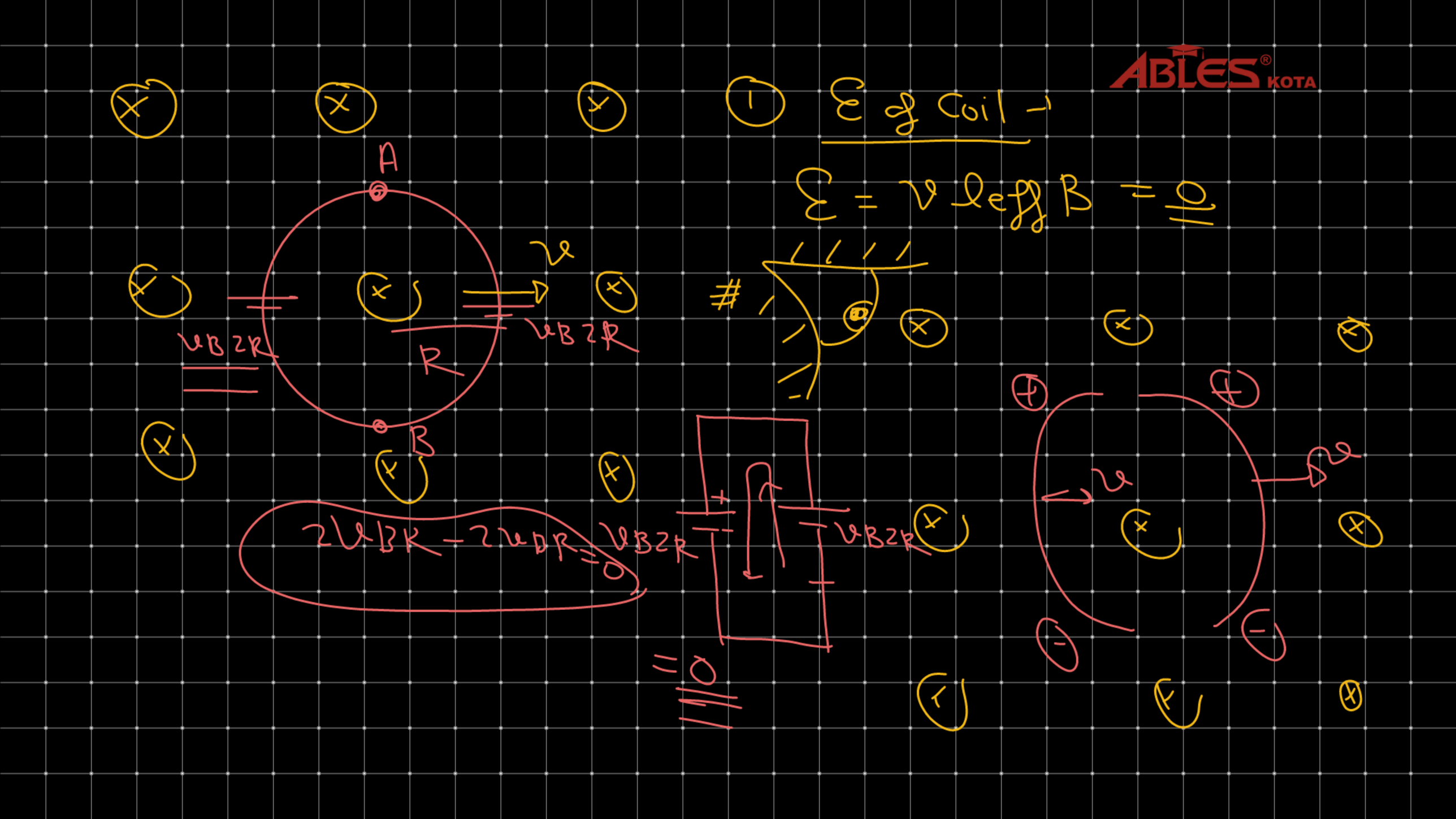


Emotion = $v_1 \, l_{eff_1} \, B_1$

Ex)



Emotional = ?


ABLES KOTA
A
B
R
v_{B2R}
v_{B2R}
$2v_{BR} - 2v_{DR} = v_{B2R}$
v_{B2R}
v
v

Q5, Q6, Q7,

Q8, Q9, Q11, (12)

Q13, Q14, Q15, Q16,

→ (12=) 12(08|2022) (Q17+Q 20)

$$\frac{d}{dt}\sin\omega t = \cos\omega t \times \frac{d}{dt}(\omega t) = \omega\cos\omega t.$$

$$\frac{d}{dt}(\sin 100\pi t) = \cos 100\pi t \times \left[\frac{d}{dt}100\pi t\right]$$

$$\cos 100\pi t\left[100\pi \frac{dt}{dt}\right]$$

$$= \cos(100\pi t)\left[100\pi\right]$$

$$= \underline{100\pi\cos(100\pi t)}$$

$$\frac{d}{dt}\left[\sin(2\pi t)\right] = \cos(2\pi t)\cdot\frac{d}{dt}(2\pi t)$$

$$= \cos(2\pi t)\left[2\pi\left(\frac{dt}{dt}\right)\right]$$

$$= 2\pi\cos 2\pi t$$