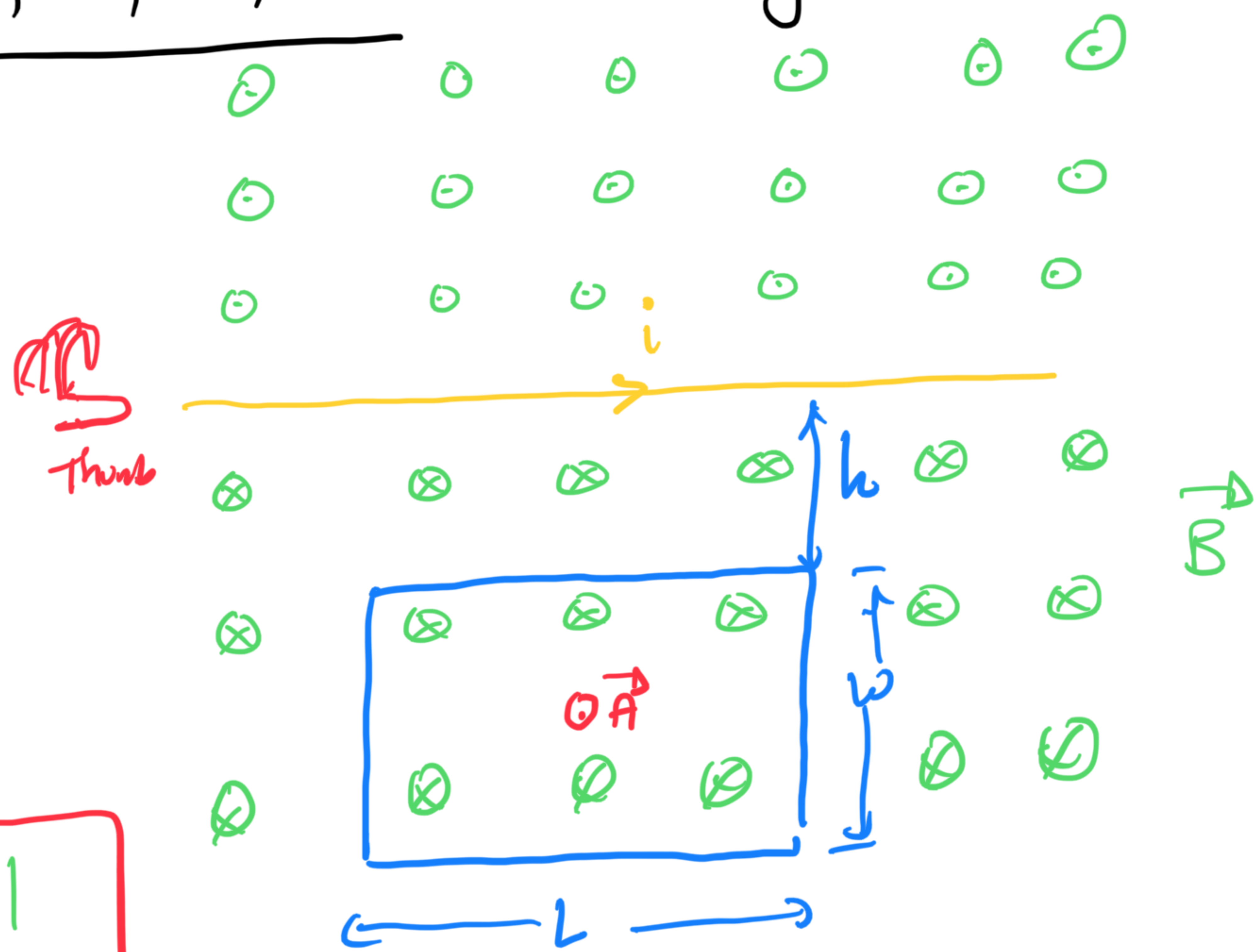
9, 10, 11, 12 → Assignment 6.

9.



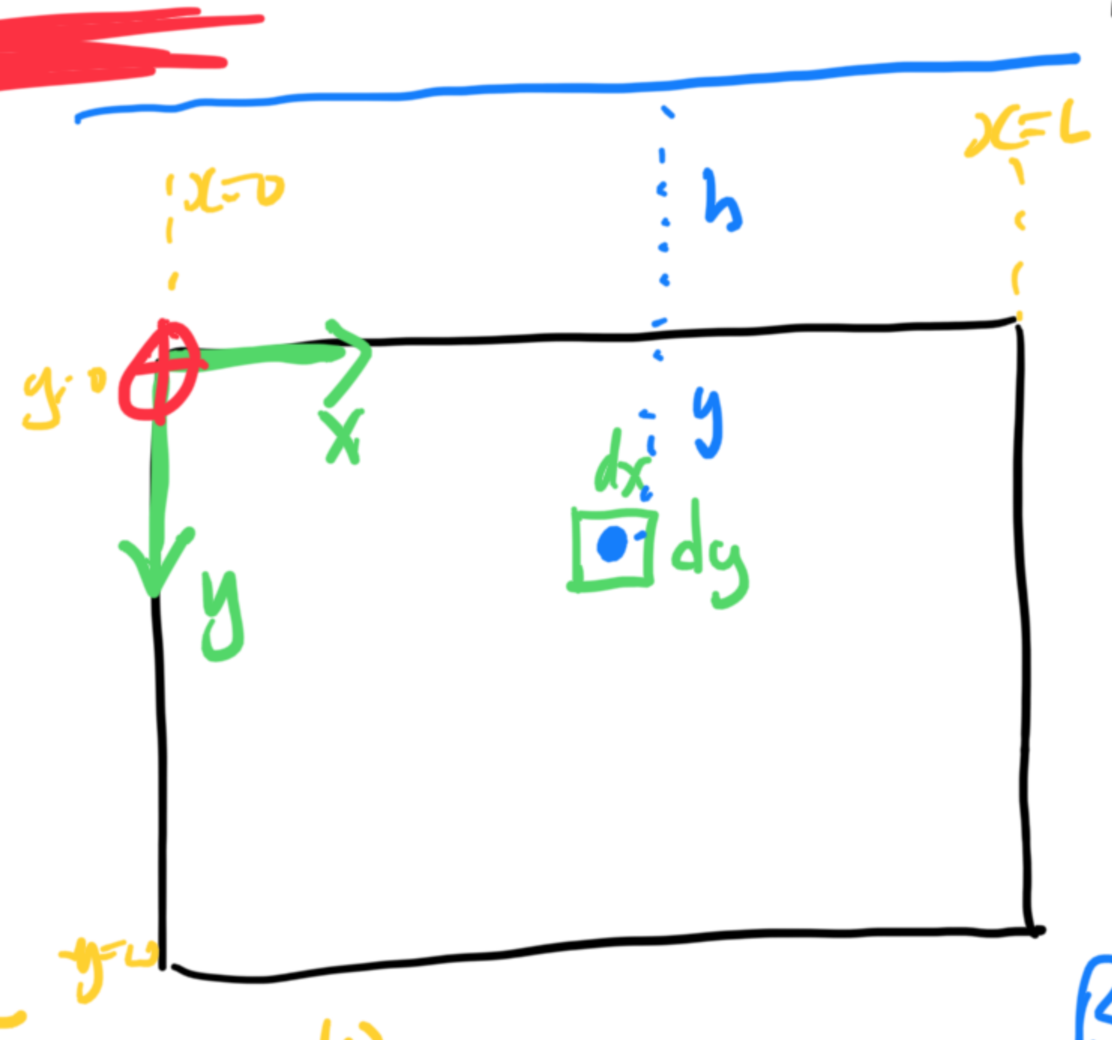
$$\boxed{|\vec{B}| = \frac{\mu_0 i}{2\pi r}}$$

← not constant

$$\Phi_M = ? = \iint_{loop} \vec{B} \cdot d\vec{A}$$

① coordinate system.

② choose area element.



$dA = dx\,dy$

$h+y$

$$B = \frac{\mu_0 i}{2\pi(h+y)}$$

$\int^{L} \int^{w}$

$$\Phi_M = \int_0 dx \int_0 dy \, \frac{\mu_0 i}{2\pi (h+y)}$$

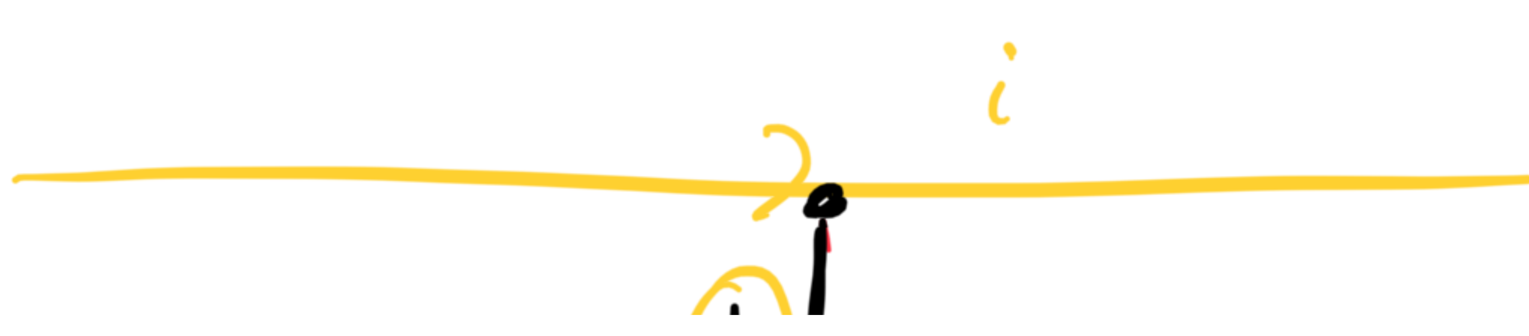
$$= \frac{\mu_0 i}{2\pi} \underbrace{\int_0^L dx}_{x\big|_0^L} \underbrace{\int_0^w dy \left(\frac{1}{h+y}\right)}_{\ln(h+y)\big|_0^w}$$

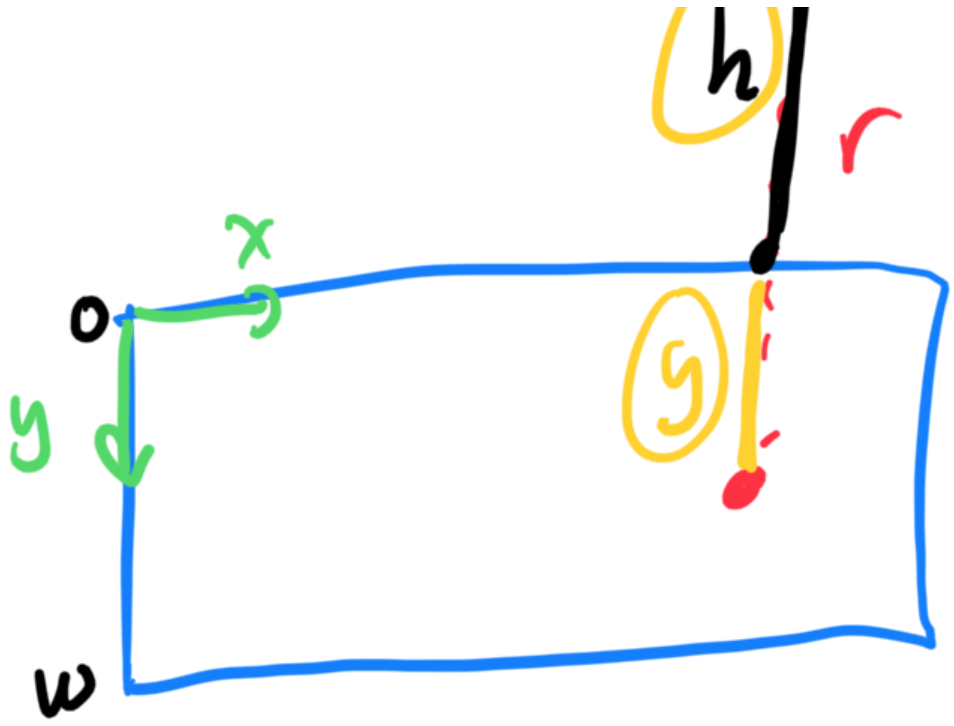
$$x\big|_0^L = L - 0 = L$$

$$\ln(h+y)\big|_0^w = \ln(h+w) - \ln(h) = \ln\left(\frac{h+w}{h}\right)$$

$$\Phi_M = \frac{\mu_0 i L}{2\pi} \ln\left(\frac{h+w}{h}\right)$$

b)





$$B = \frac{\mu_0 i}{2\pi r}$$

distance.

$$B = \frac{\mu_0 i}{2\pi (h+y)}$$

?

$$\Phi_m = \frac{\mu_0 i L}{2\pi} \ln\left(\frac{h+w}{h}\right)$$

$$C = \frac{\mu_0 L}{2\pi} \ln\left(\frac{h+w}{h}\right)$$

$$\Phi_m = C\, i \qquad = *$$

$$\frac{d\Phi_m}{dt} = C \frac{di}{dt} \qquad i = a + bt$$

$$= C b \qquad \frac{di}{dt} = b$$

1

$$V_{ind} = -N \frac{d\Phi_m}{dt}$$

$4\pi \times 10^{-7}$ 1.15 14 .1

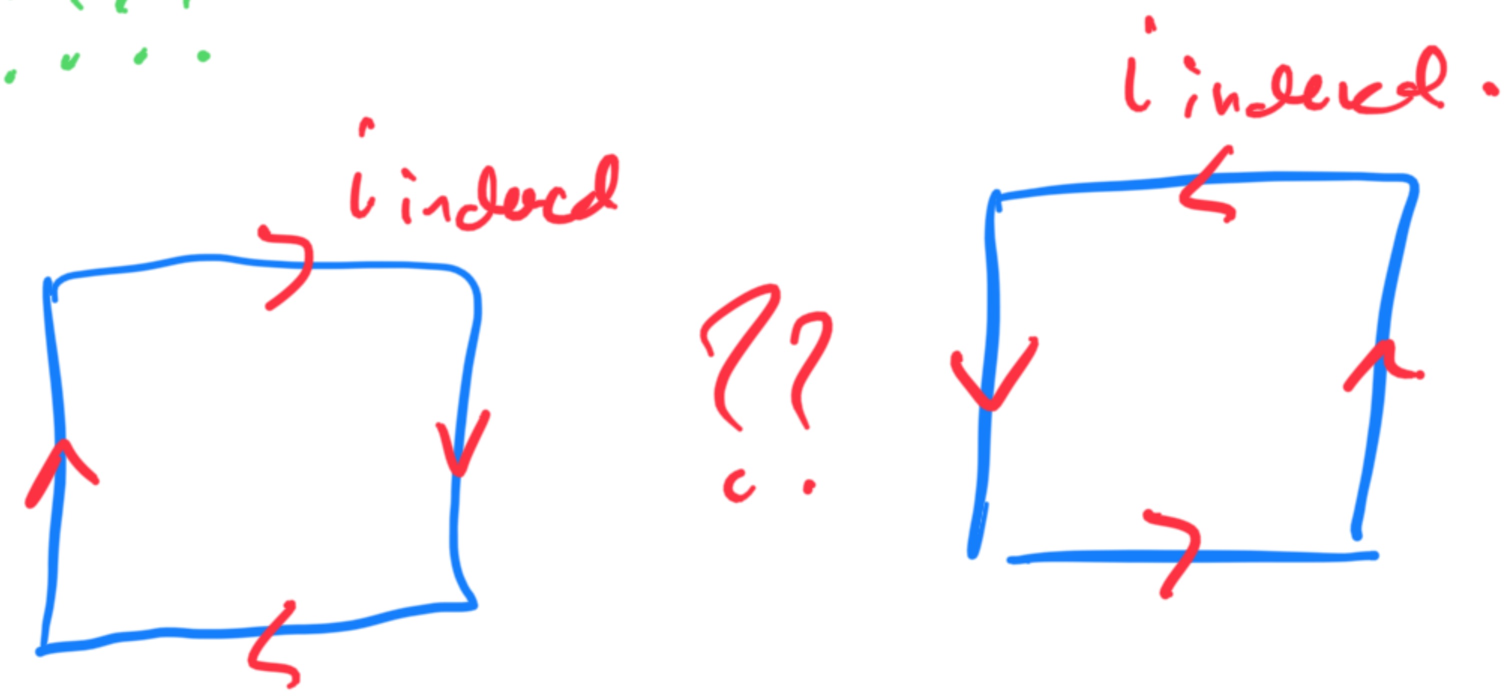
$$= -Cb = -\frac{\mu_0 L b}{2\pi} \ln\left(\frac{h+w}{h}\right)$$

$.01$

$$= -7.72 \times 10^{-6} \text{ V}$$

$$= -7.72\ \mu\text{V}$$

What direction does the current flow in ????



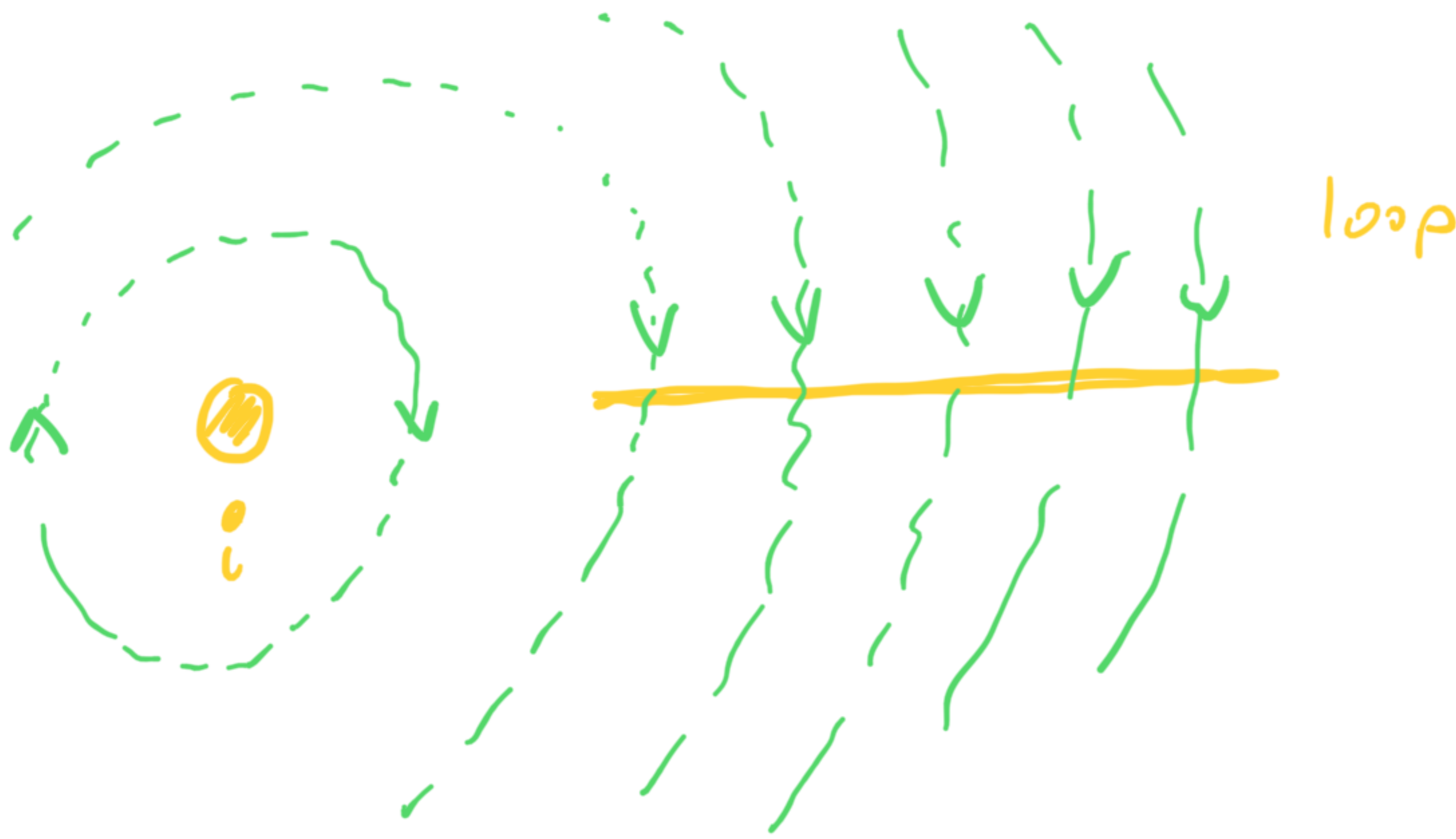
Lenz's Law

→ $\boxed{\text{nature hates us!}}$!

→ The current in the loop will flow in a direction that creates a magnetic field so as to ... flux that

Oppose the changing flux that created it.

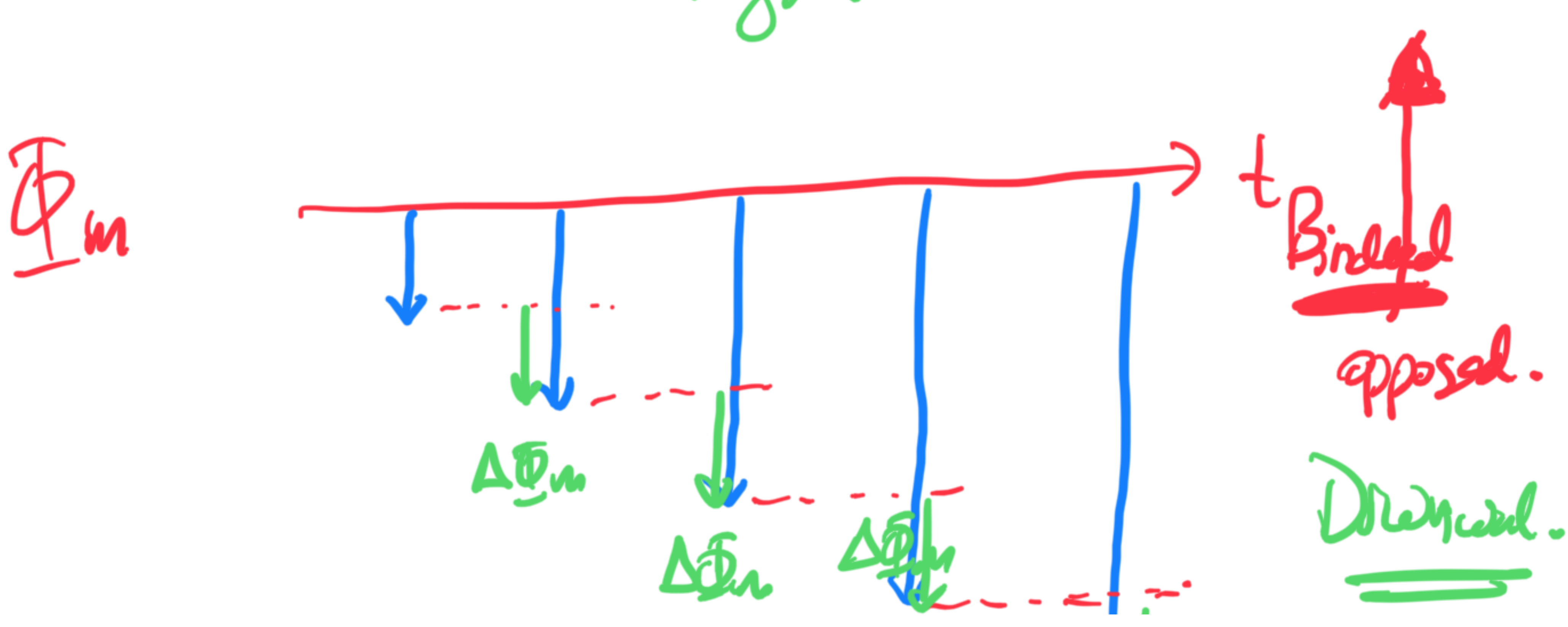
Side View

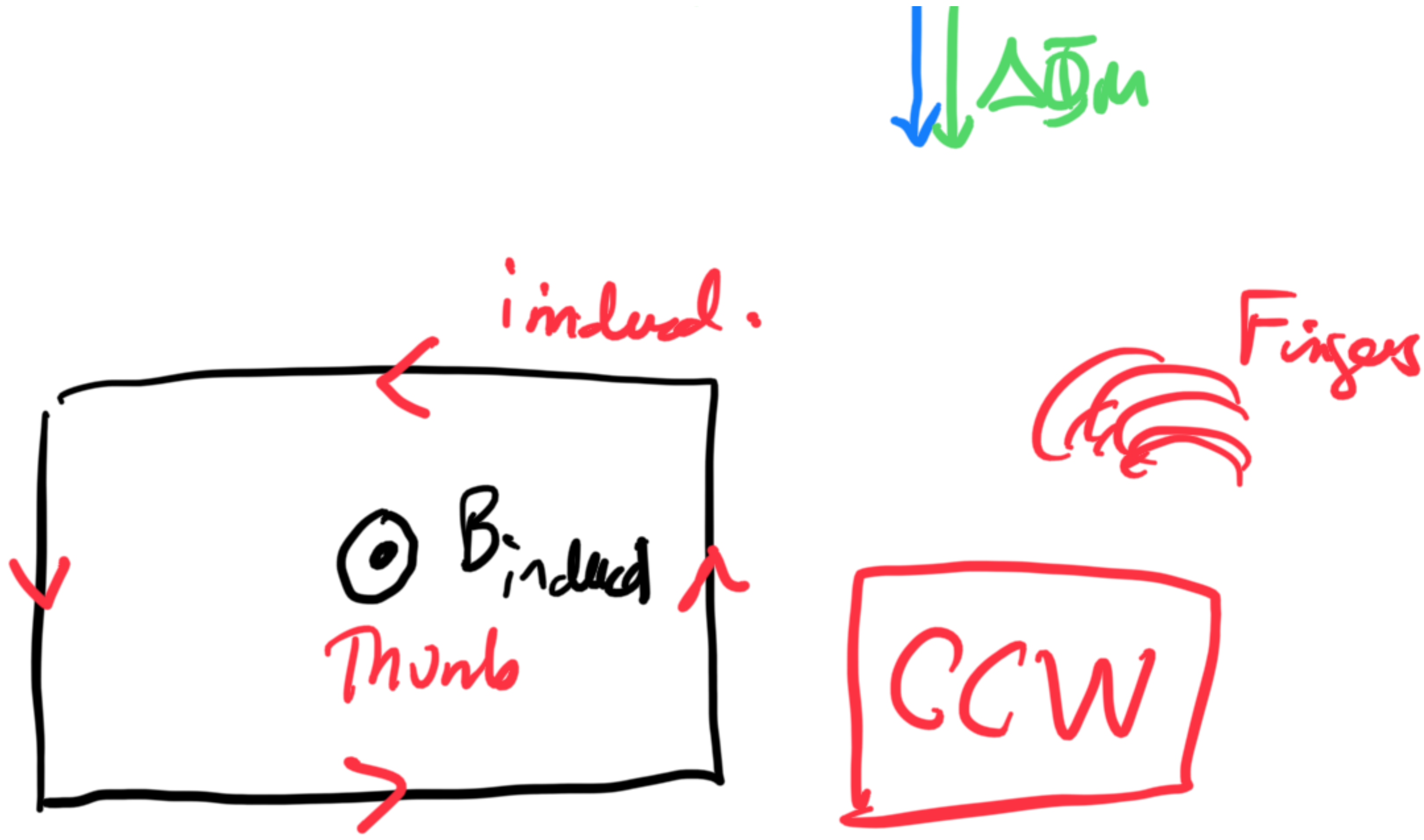


$i = a + bt$ → magnetic flux is increasing with time!!

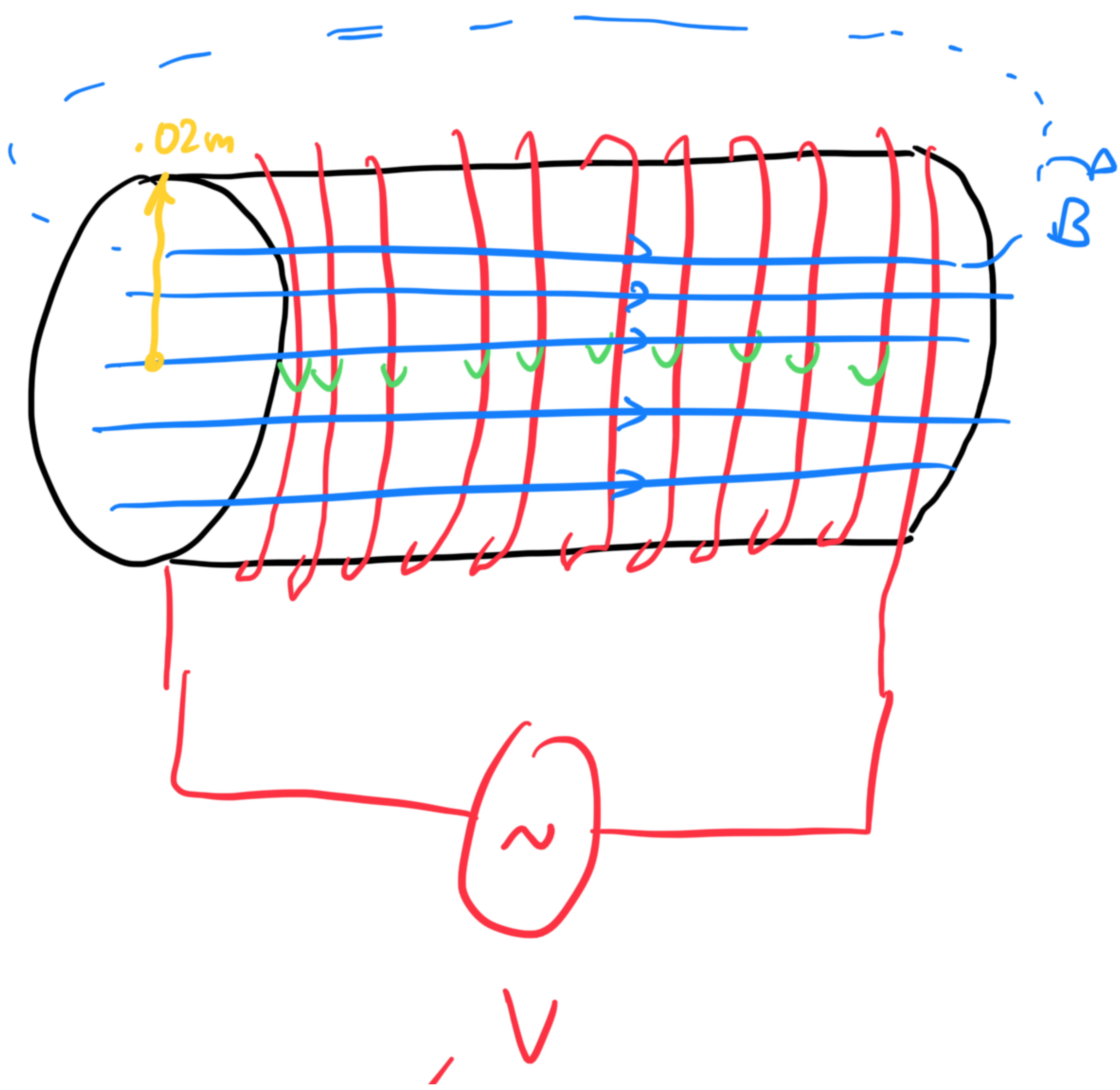
$$V_{ind} = -N \frac{d\Phi_m}{dt}$$ +ve

negative.





10.

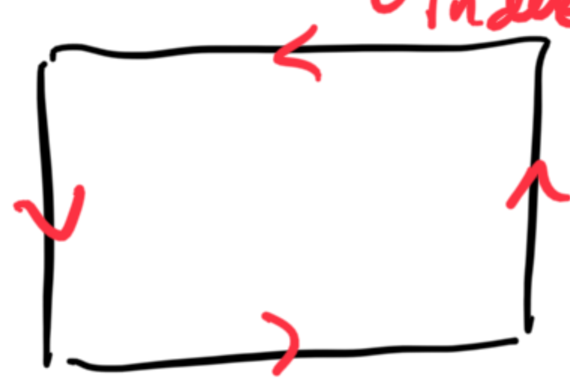


$$|\vec{B}_c| = \mu_0 \underbrace{\left(\frac{N}{L}\right)}_{\text{turns/m} \, = \, 1000} i$$

$i \leftarrow 3\sin(90\pi t)$

Take a step Back;

$i_{induced} \rightarrow$ why ??



Moving charge $\rightarrow$ Electric field

??

$V_{induced} \rightarrow$ induced current.

$$\boxed{V_{induced} \equiv -\int \vec{E}_{induced} \cdot d\ell}$$

100p

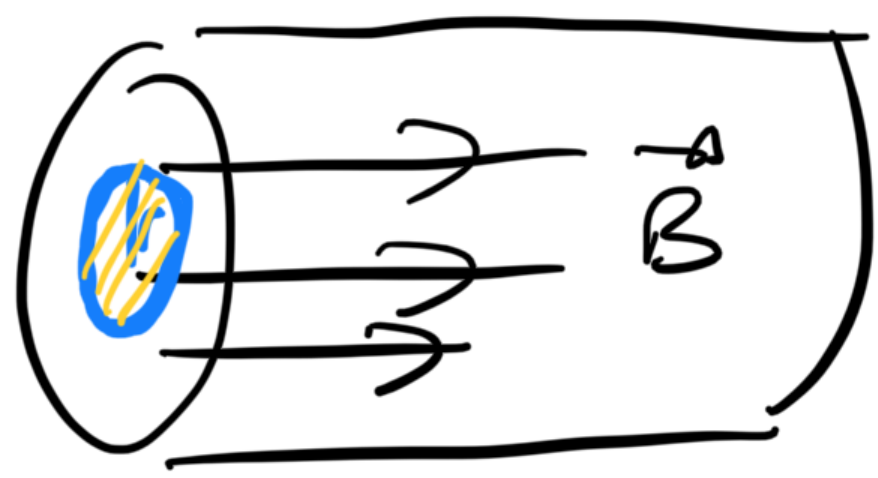
$$-N\frac{d\Phi_m}{dt}$$

Maxwell's Equation

$$\oint \vec{E}\cdot d\vec{l} = \frac{1}{\cancel{N}}\,\frac{d\Phi_m}{dt}$$

LHS RHS

RHS



1000

$$|\vec{B}| = \mu_0\left(\frac{N}{L}\right) i \leftarrow 3\sin 90\pi t$$

$\Phi_m = BA$

$$= 3000\,\mu_0 \sin 90\pi t$$

$$\Phi_m = 3000\,\mu_0 \sin(90\pi t)\cdot \pi r^2$$

$$\frac{d\Phi_m}{dt} = 3000\,\mu_0 \cos(90\pi t) \times 90\pi \cdot \pi r^2$$

= RHS

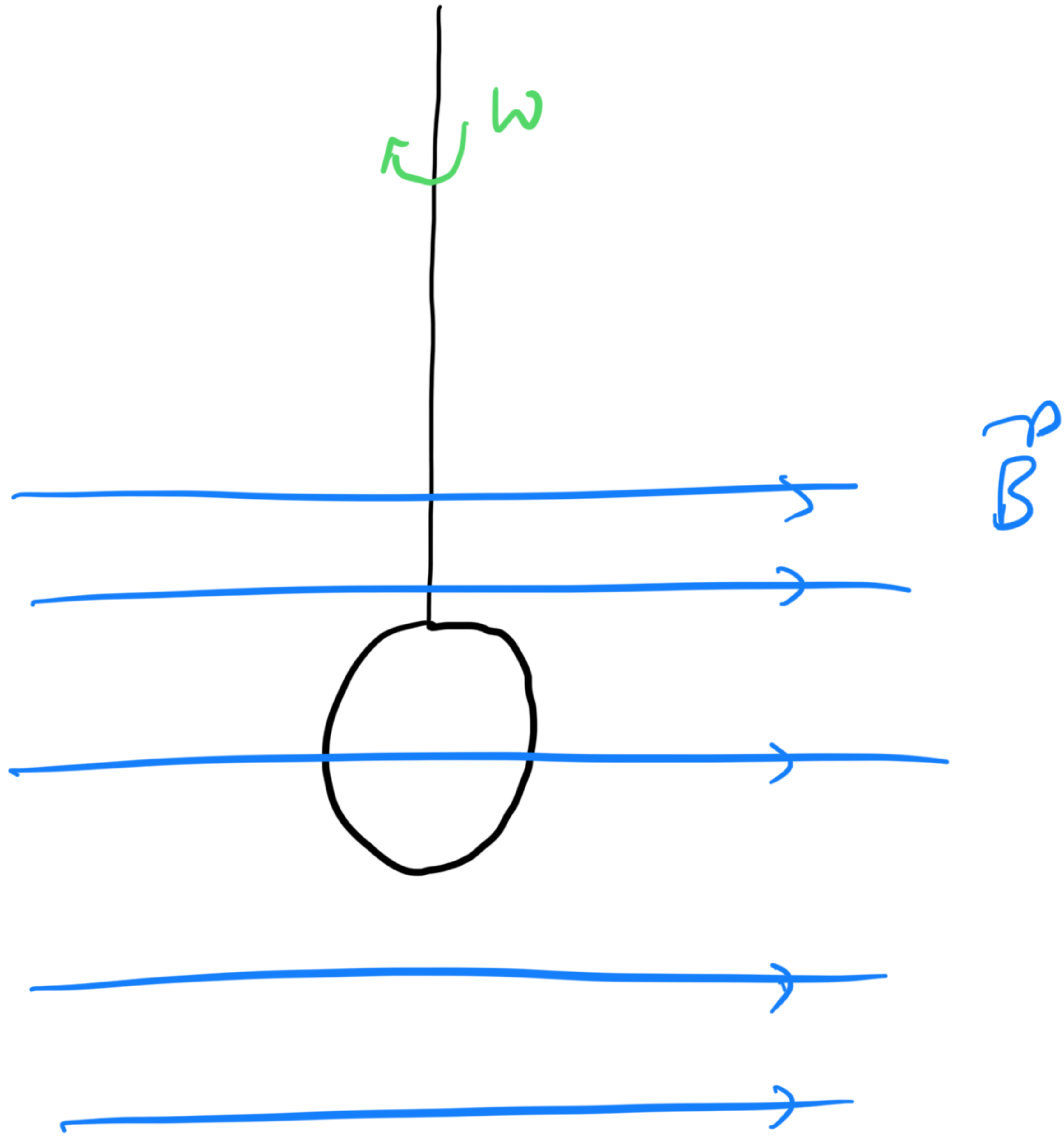
LHS

$$\oint_{loop} \vec{E} \cdot d\vec{l} = E \cdot 2\pi r$$

$$E \cdot \cancel{2\pi r} = \frac{3000\,\mu_0 \cos(90\pi t)}{\underset{45}{\cancel{90}}\pi \cdot \cancel{\pi r^2}}$$

$$E = 5.33 \times 10^{-3} \cos(90\pi t)$$

11.



$$\Phi_m = BA\cos\theta$$

$$\Phi_m = BA\cos(\omega t)$$

$$\frac{d\Phi_m}{dt} = -BA\omega\sin(\omega t)$$

.2 T

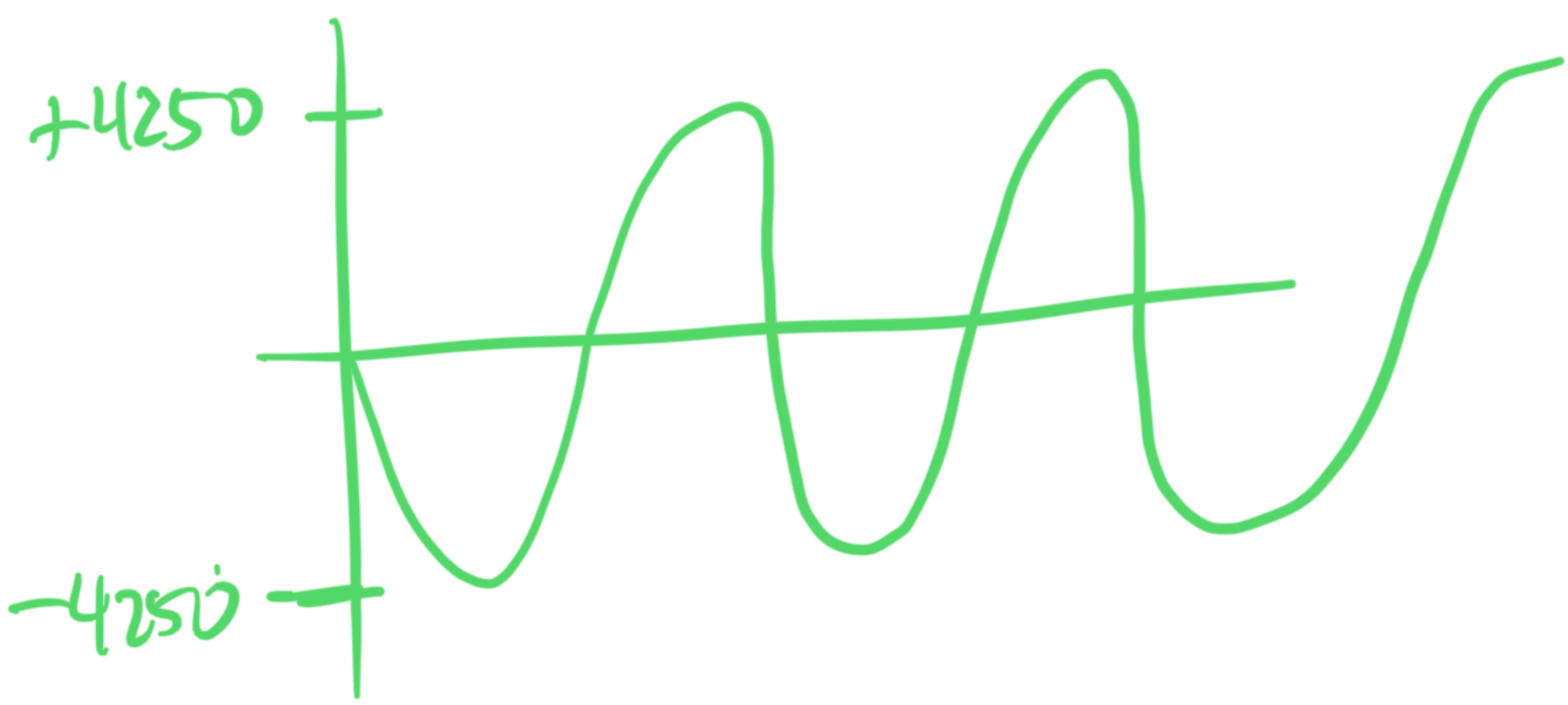
$$\boxed{V_{ind} = -NAB\omega\sin(\omega t)}$$

600 /mi

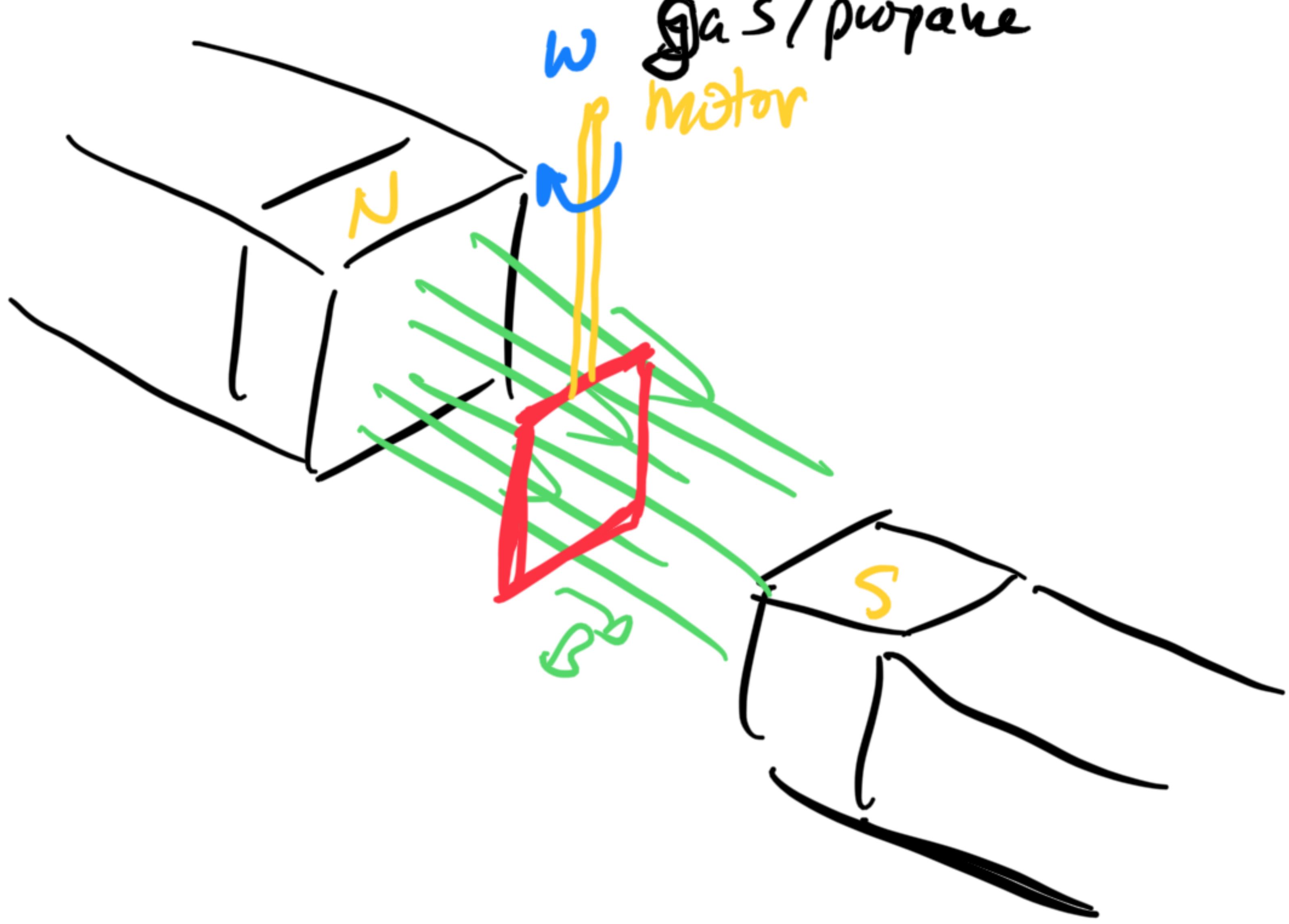
$60 \frac{rev}{s} \times 2\pi \frac{rad}{rev}$

$= 120\pi$

$$V_{ind} = -4250 \sin(120\pi t)$$



12.



$$\Phi_M = \vec{B}\cdot\vec{A} = BA\cos\theta$$

$$= BA\cos(\omega t)$$

$$\underbrace{.8\,(.12)(.12)}_{11.52\times10^{-3}}$$

$$\omega = 2\pi \overset{30}{f}$$

$$= 60\pi$$

$$= 188.50$$

$$\boxed{\Phi_M = (11.52\times10^{-3})\cos(\underline{188.50}\,t)}$$

$$V_{induced} = -N\frac{d\Phi_m}{dt}$$

$$= 41\,(11.52 \times 10^{-3})\,(188.50)\,\sin(188.50t)$$

$$V_{induced} = 2.171 \sin(188.50t)$$

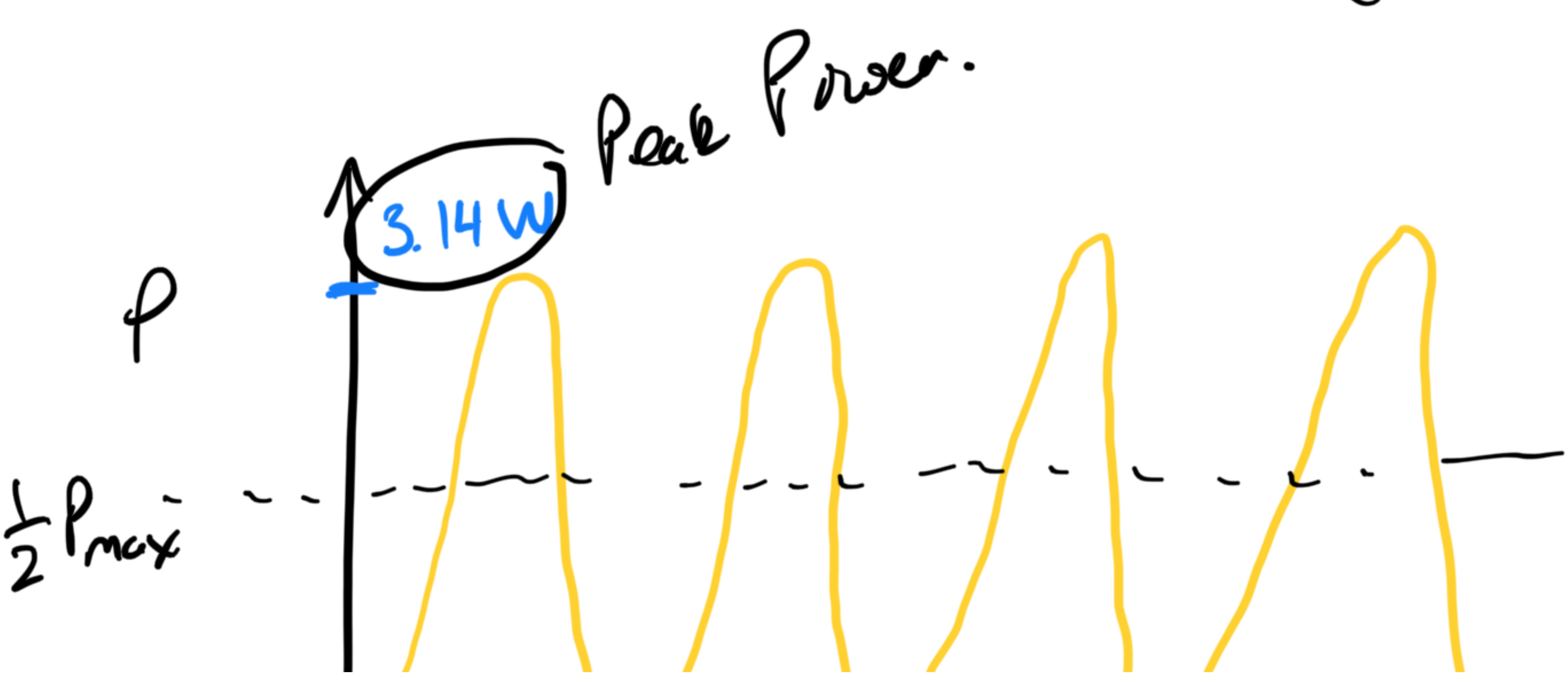
$\times$

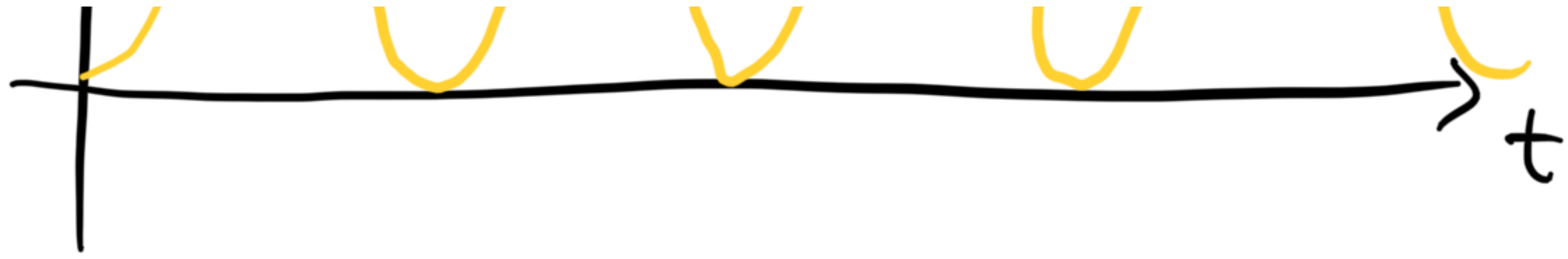
$$i_{induced} = \frac{V}{R} = 1.448 \sin(188.50t)$$

$$P = iV = 3.14 \sin^2(188.50t)$$

$$\boxed{P = \tau \cdot \omega} \qquad \tau = \frac{P}{\omega}$$

$$= 16.68 \times 10^{-3} \sin^2(188.50t)$$





$$P_{avg} = \frac{3.14}{2} = \underline{\underline{1.57\ W}}$$

Home Depot : $\boxed{12000\ W}$

Peak !!

$$\theta = \omega t$$

$$\underbrace{2\pi}\underset{(30)}{f} = 60\pi = \underline{\underline{188.50}}$$

Interesting Physics !!