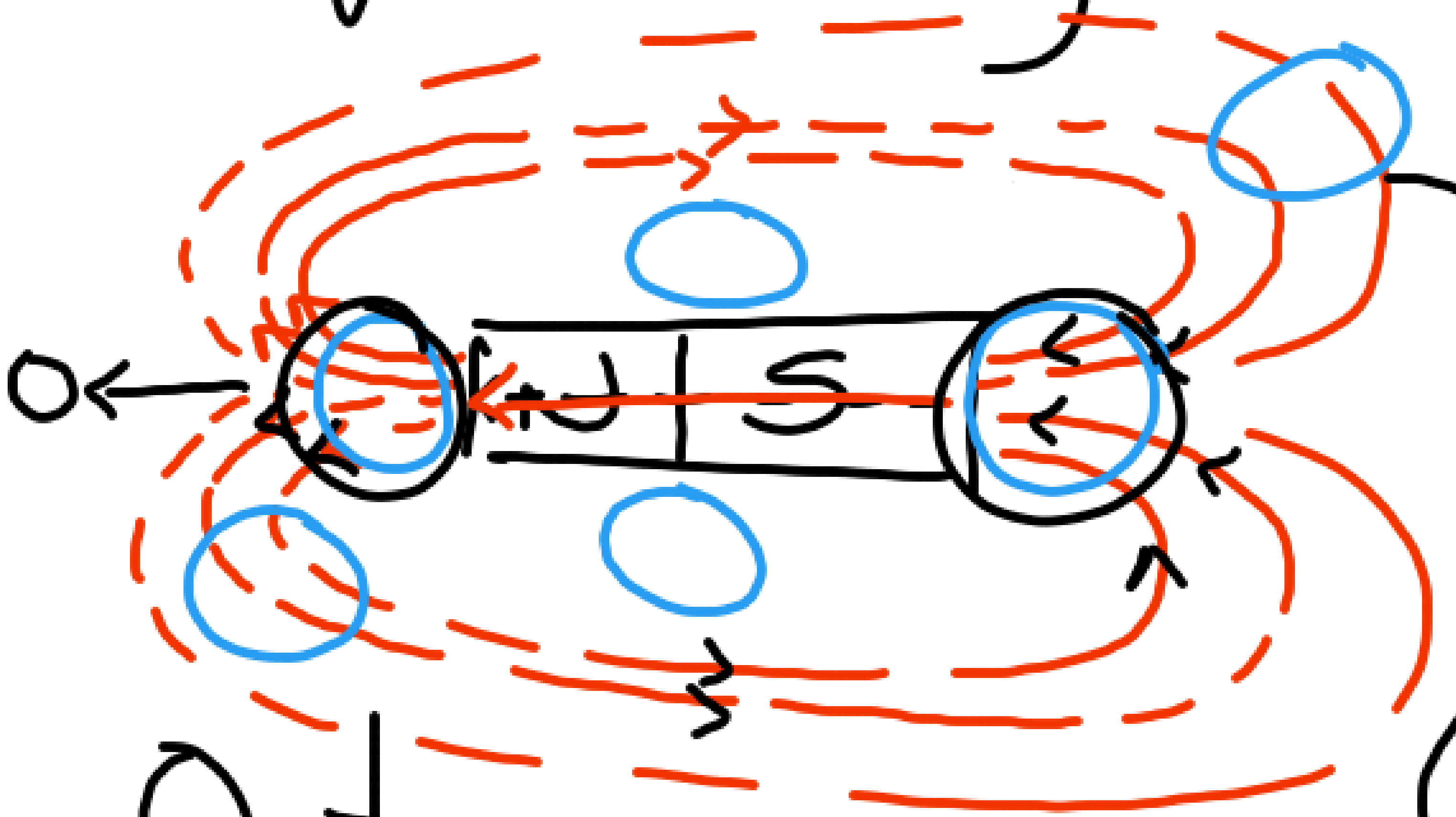
Bar Magnet



Magnetic flux "field" Lines (ϕ_m)

Out: N $\longrightarrow$ S

In: S $\longrightarrow$ N

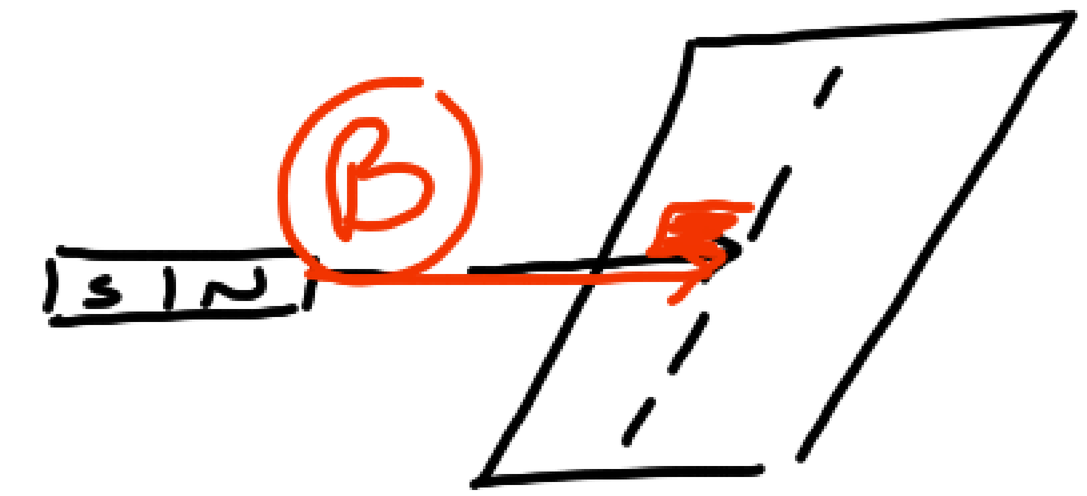
$\Rightarrow$ M. flux density: (B)

$$\boxed{B = \frac{\phi_{m\perp}}{A}}$$

$$\boxed{\text{Tesla} = \frac{\text{weber}}{m^2}}$$

$$B = \frac{\phi_{m\perp}}{A}$$

$$\boxed{\phi_m = BA}$$

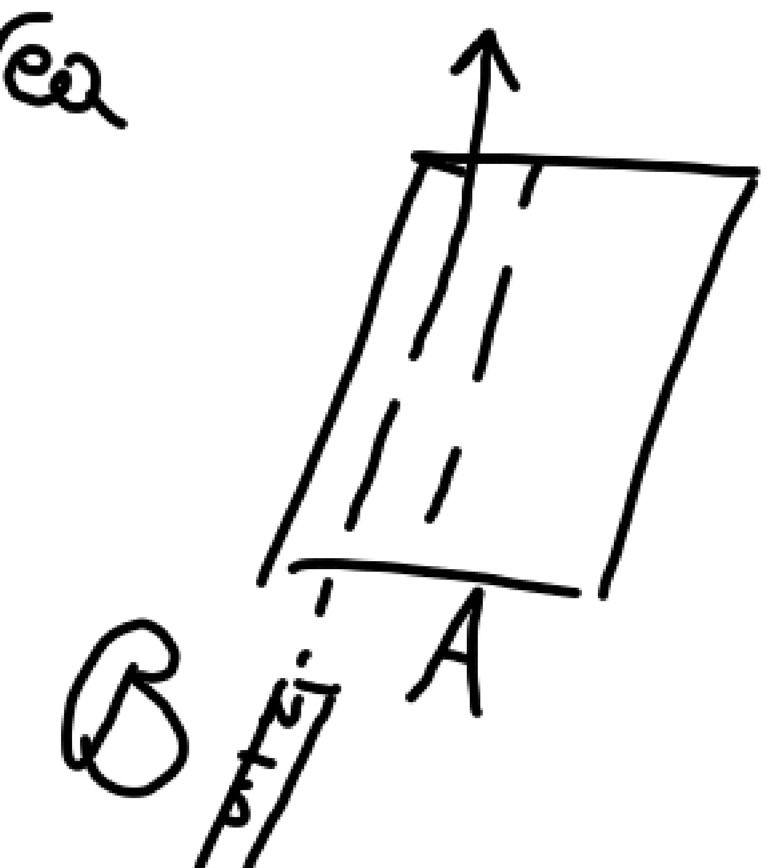


$\phi_1 = BA\cos\theta_1$ — normal on A and MF

or

$\phi = BA\sin\theta_2$ — MF, Area

$$\phi = BA\sin 0 = \boxed{\text{zero}}$$

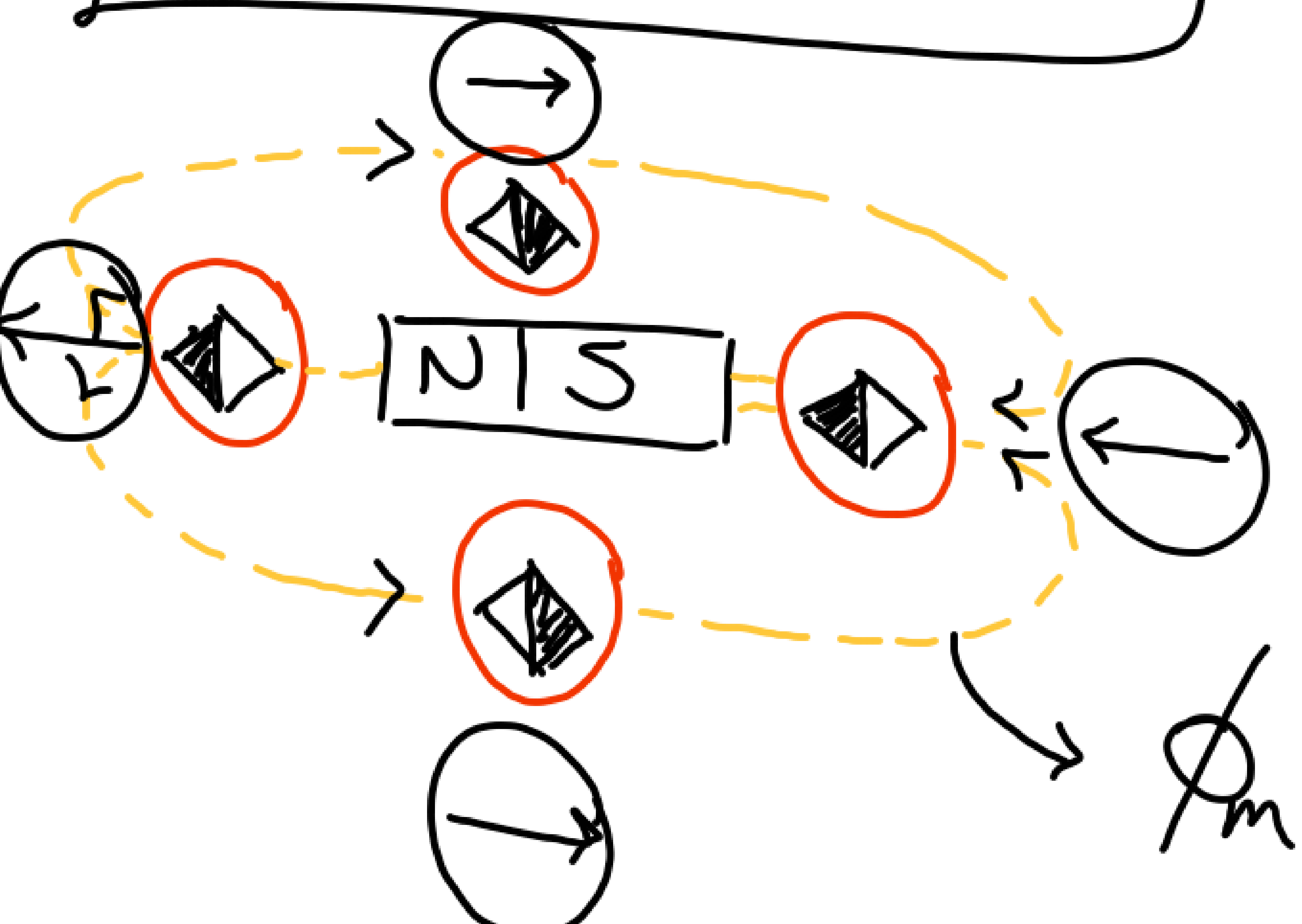


$$\boxed{\phi = BA \cos\theta}$$

$\cos\theta$ — normal to Area, MF

$\sin\theta$ — Area, MF

$$\boxed{\text{weber} = \text{Tesla}\cdot m^2}$$

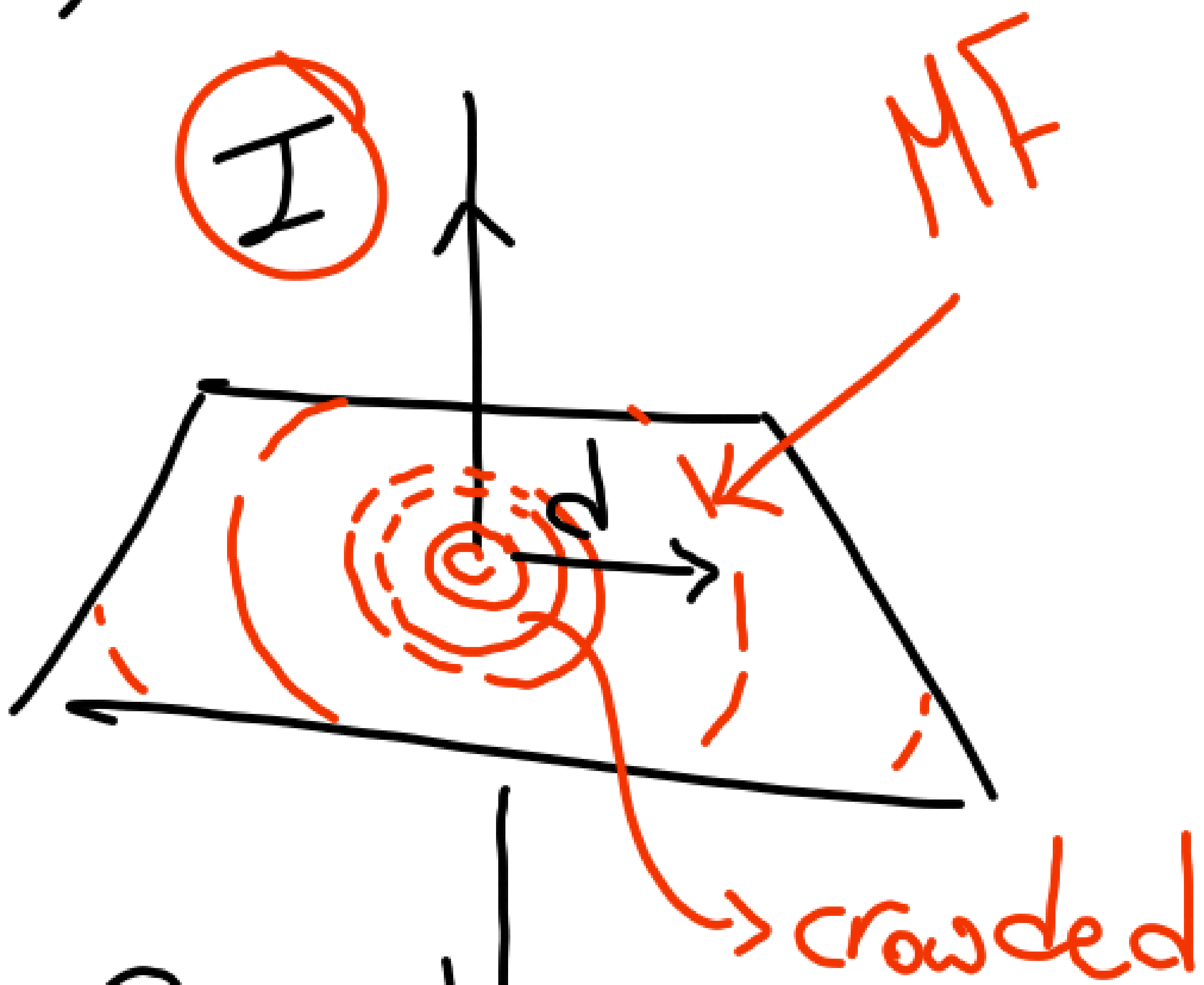


Conductor + Current = MF

- St. wire
- Circular coil
- Solenoid

1 St. wire

a) Shape



1) Concentric circles
2) Crowded near the wire
3) As $I\uparrow$, more crowded
4) As $d\uparrow$, Less crowded.

b) Law:

$B \propto I$ $\quad B \propto \frac{1}{d}$

$B \propto \frac{I}{d}$

$$\boxed{B = \frac{\mu}{2\pi}\frac{I}{d}}$$

Magnetic permeability

$$\mu = \frac{B\, 2\pi d}{I}$$

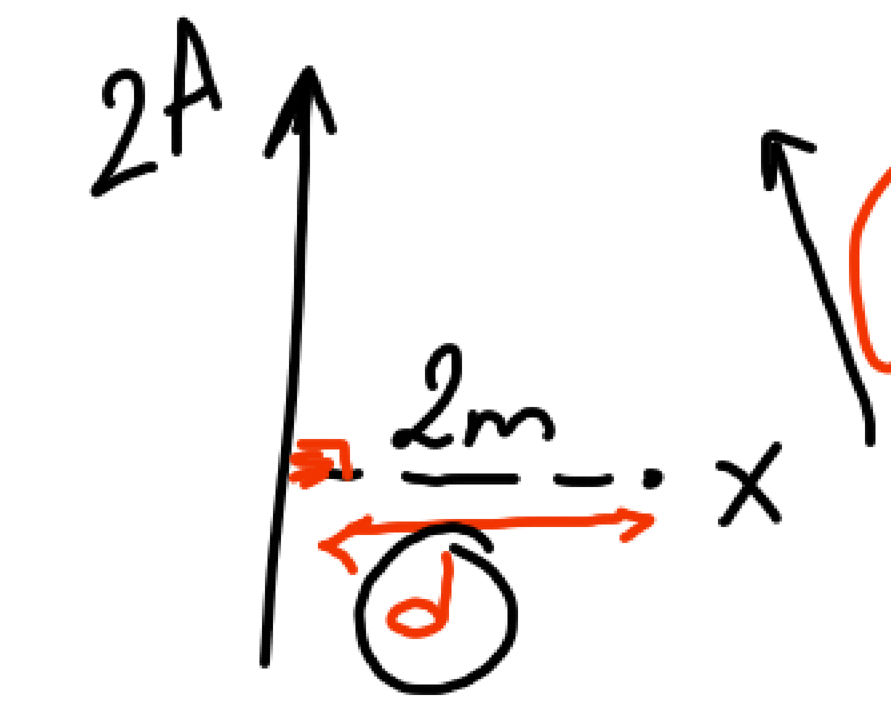
* $\boxed{\frac{\text{Tesla.m}}{\text{Amp}}}$ $\quad \frac{\text{wb.}\cancel{\text{m}}}{\text{m}^{\cancel{2}}\text{.Amp}}$ $\quad$ * $\boxed{\frac{\text{wb}}{\text{Amp.m}}}$

$$B = \frac{\cancel{4\pi}\times 10^{-7}}{\cancel{2\pi}}\frac{I}{d}$$

$$\boxed{B = 2\times 10^{-7}\frac{I}{d}}$$

Factors:

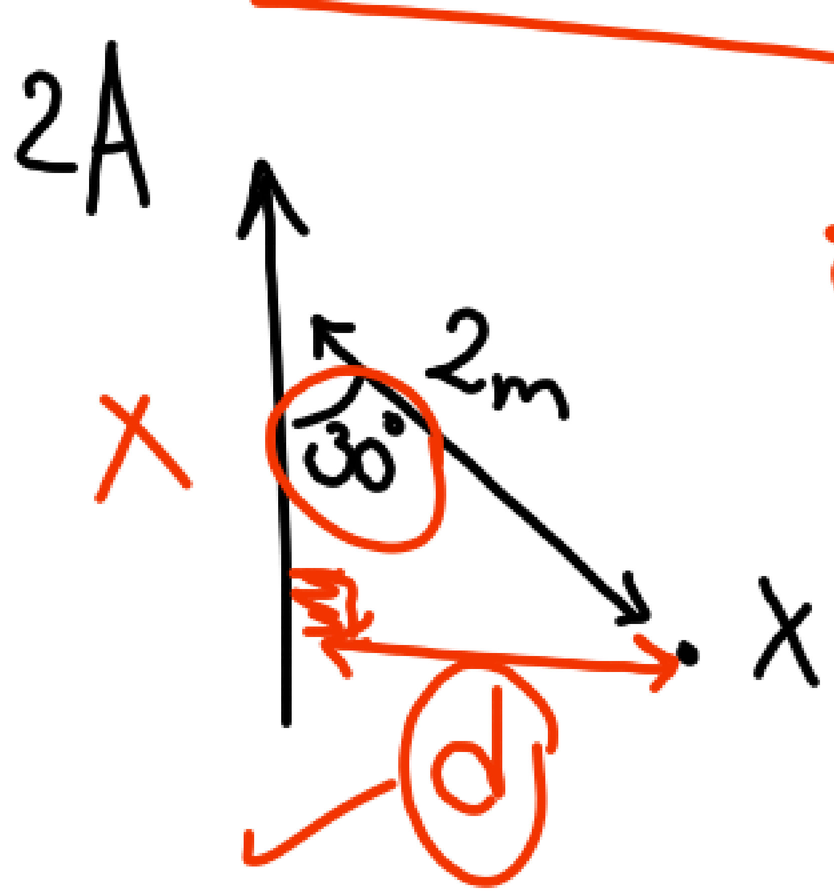
1) μ
2) I
3) Normal distance



$$B = 2\times10^{-7}\,\frac{I}{d}$$

$$B = 2\times10^{-7} \times \frac{2}{2}$$

$$= \boxed{2\times10^{-7}\ T}$$



$$\sin 30 = \frac{d}{2}$$

$$\frac{1}{2} = \frac{d}{2}$$

$$\boxed{d = 1\,m}$$

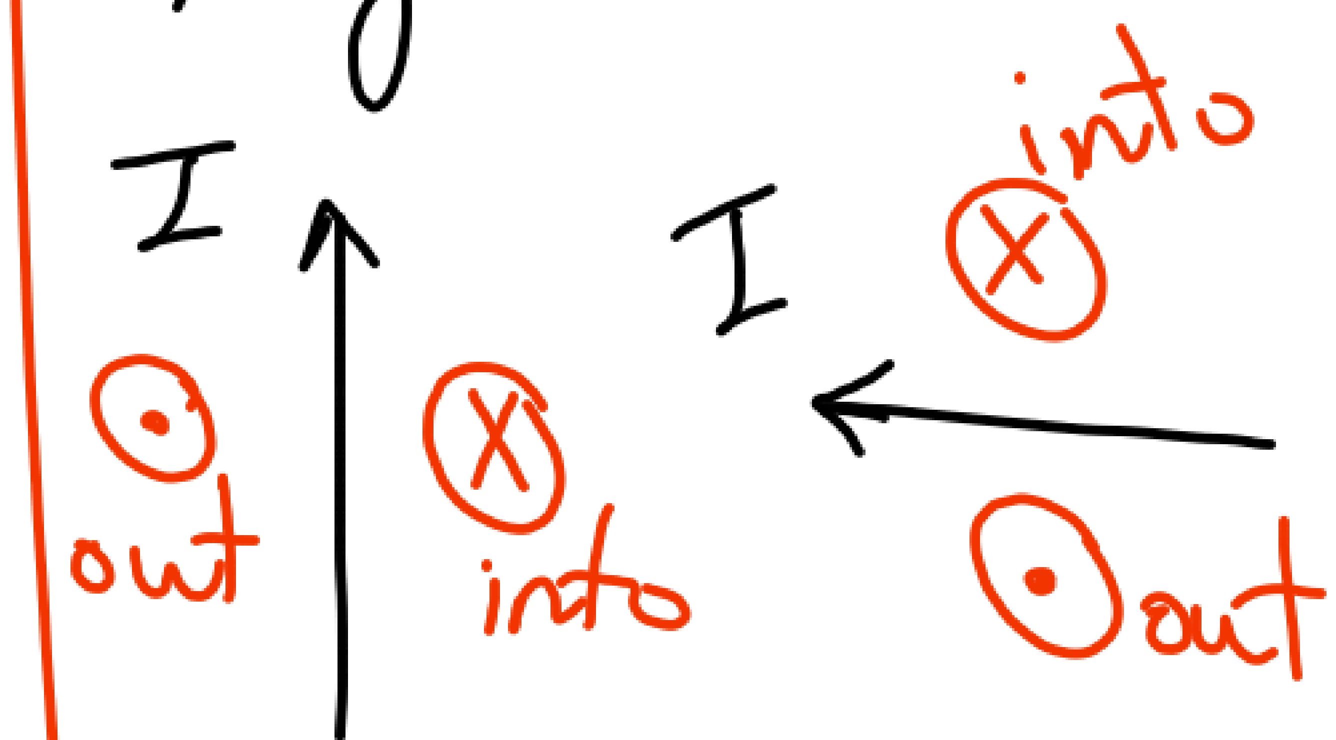
$$B = 2\times10^{-7} \times \frac{2}{1} = \boxed{4\times10^{-7}\ T}$$

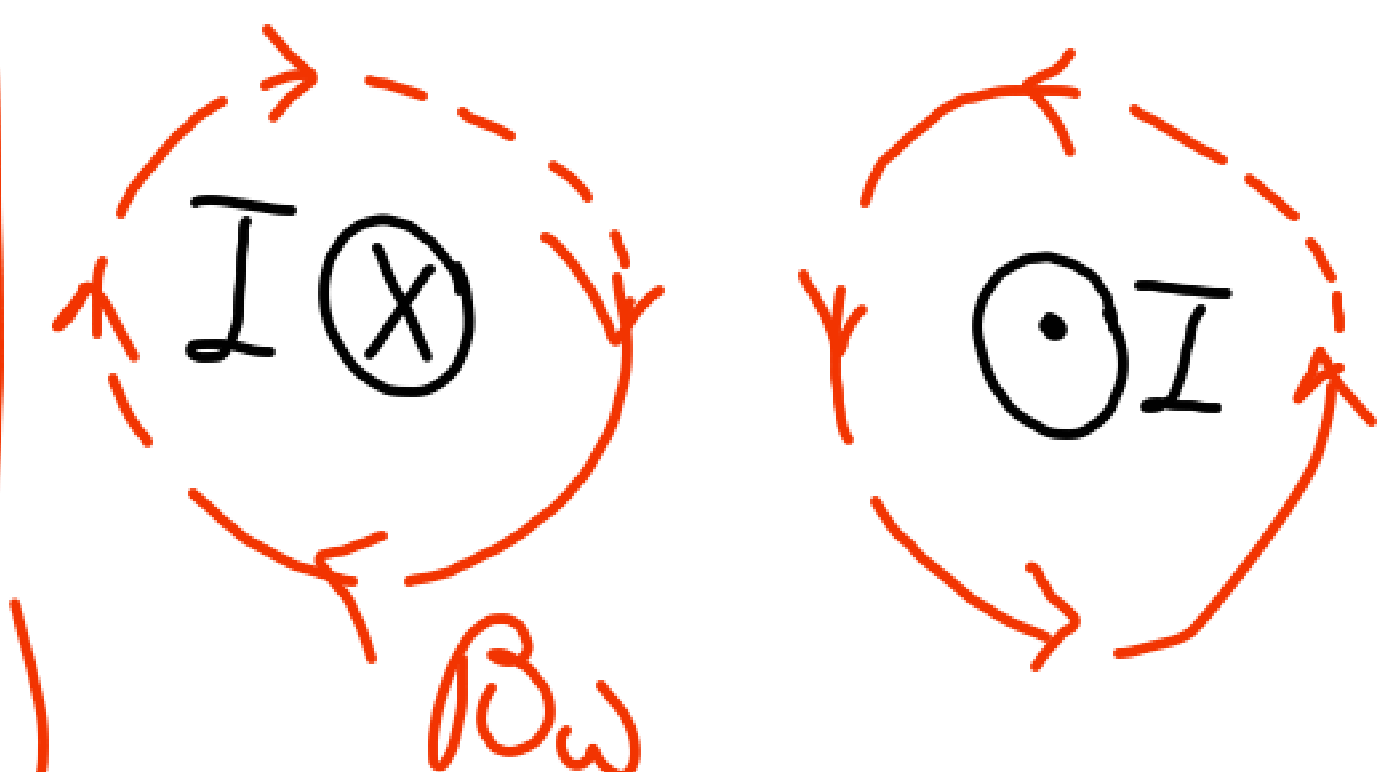
c) Direction:

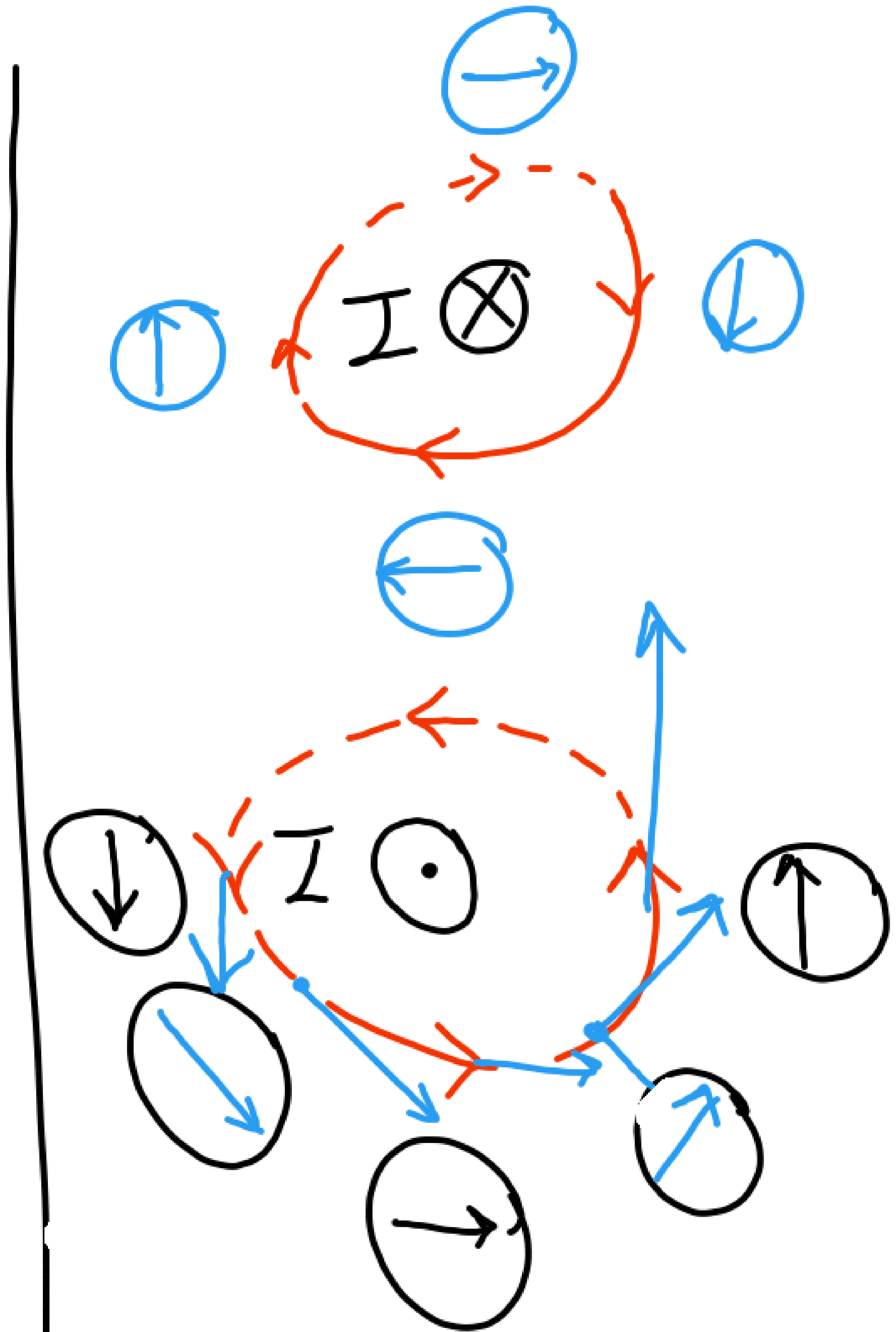
→ A.R.H.R:

Thumb → I

Fingers → MF

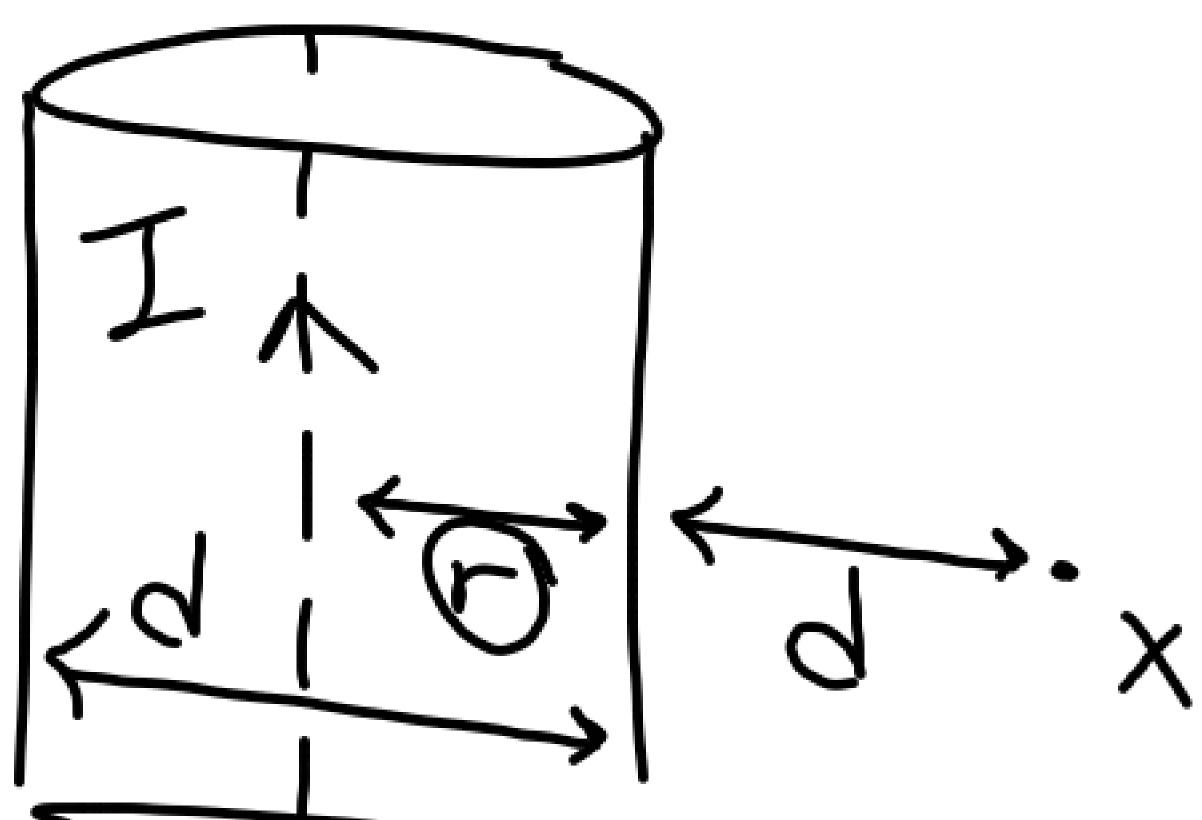






Problems:

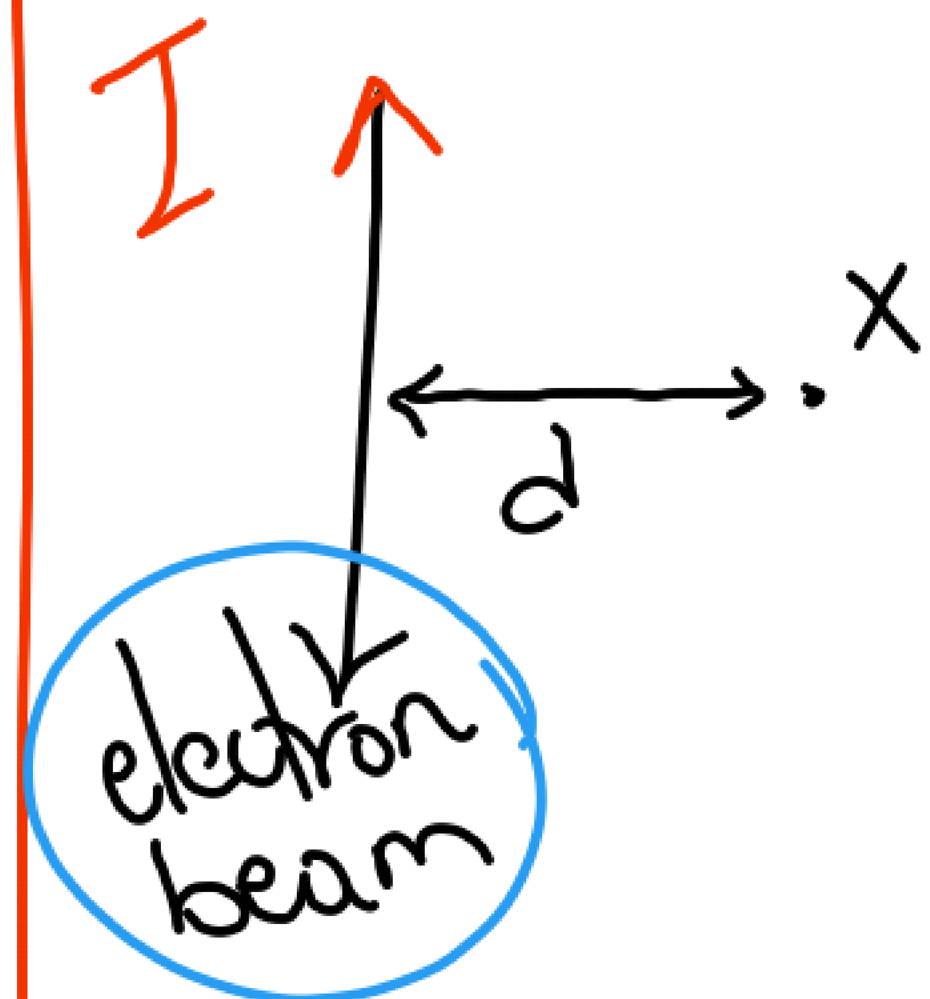
1 Wire of given (r)



$$\boxed{B = 2\times10^{-7} \times \frac{I}{d+r}}$$

$r = \frac{\text{diameter}}{2}$

2 Electron beam



ال current
عكس اتجاه
حركة ال é

$$B = 2\times10^{-7} \times \frac{I}{d}$$

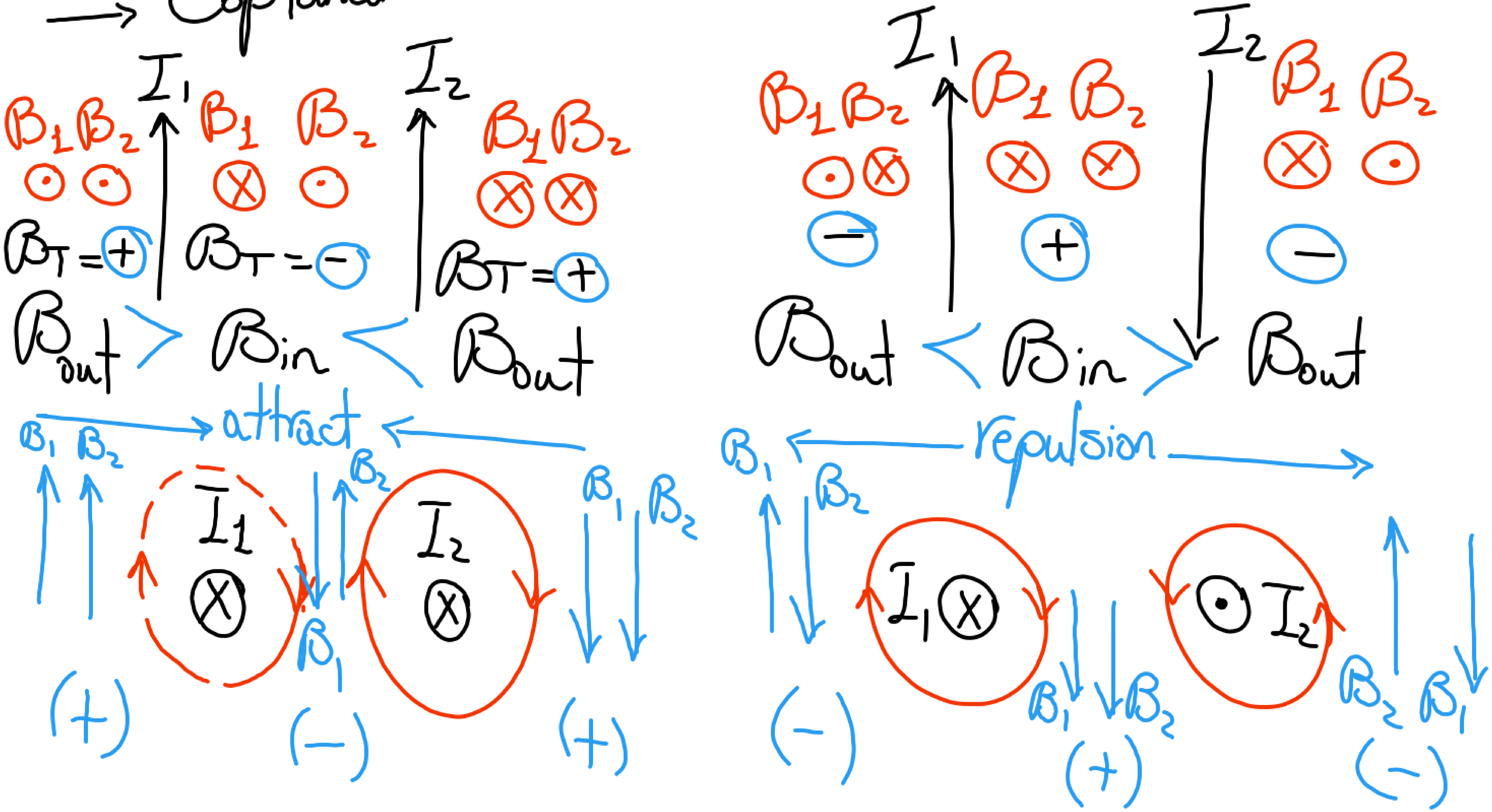
$$I = \frac{Q}{t} = \frac{n \times e}{t}$$

$e \rightarrow 1.6\times10^{-19}\,c$

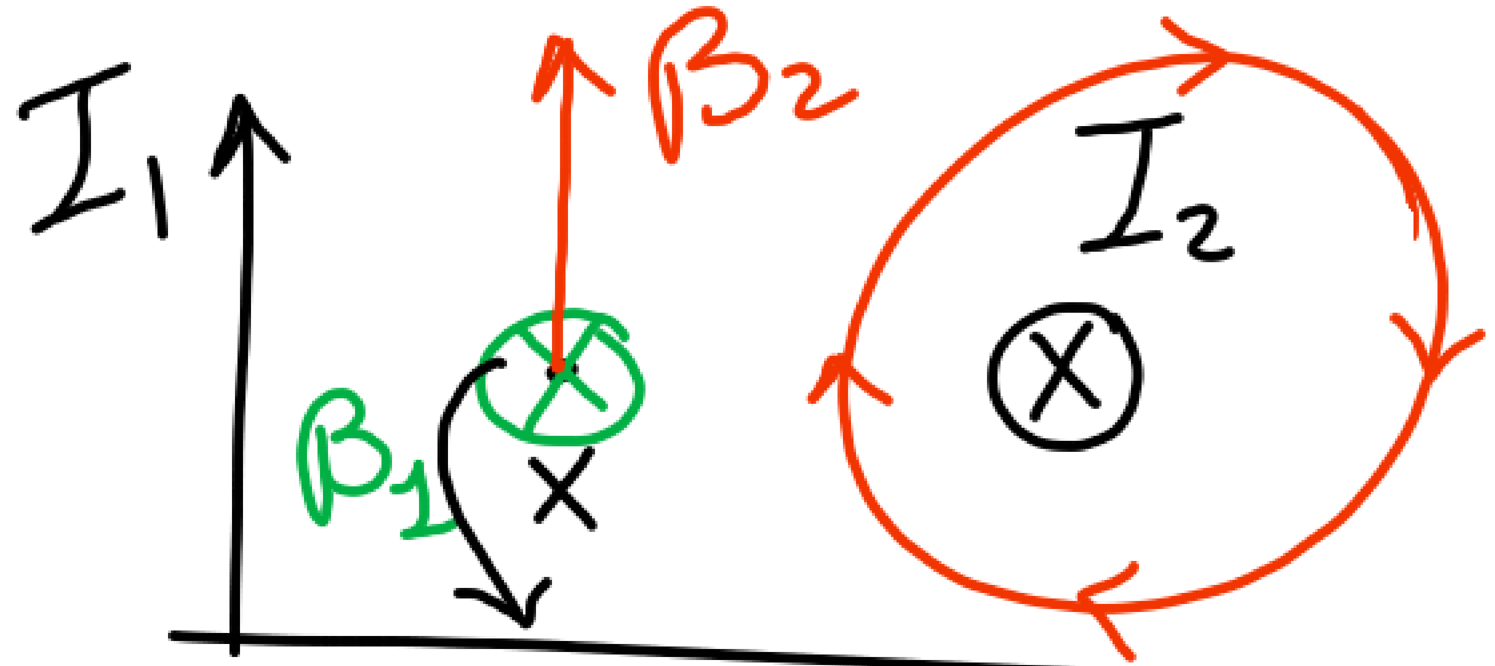
$\frac{n}{t}$ → rate of electrons

$\boxed{3}$ Two wires

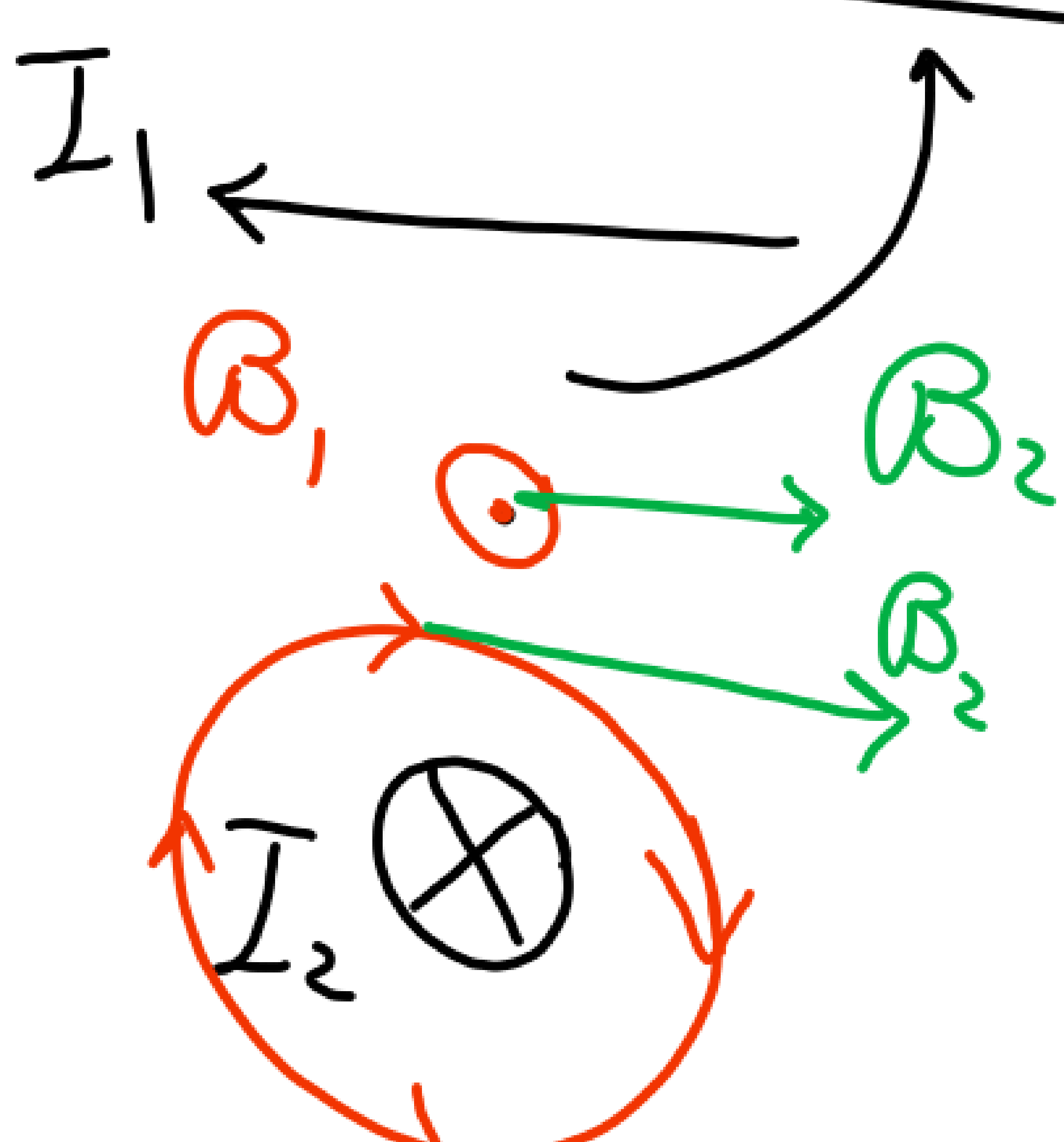
→ Coplanar

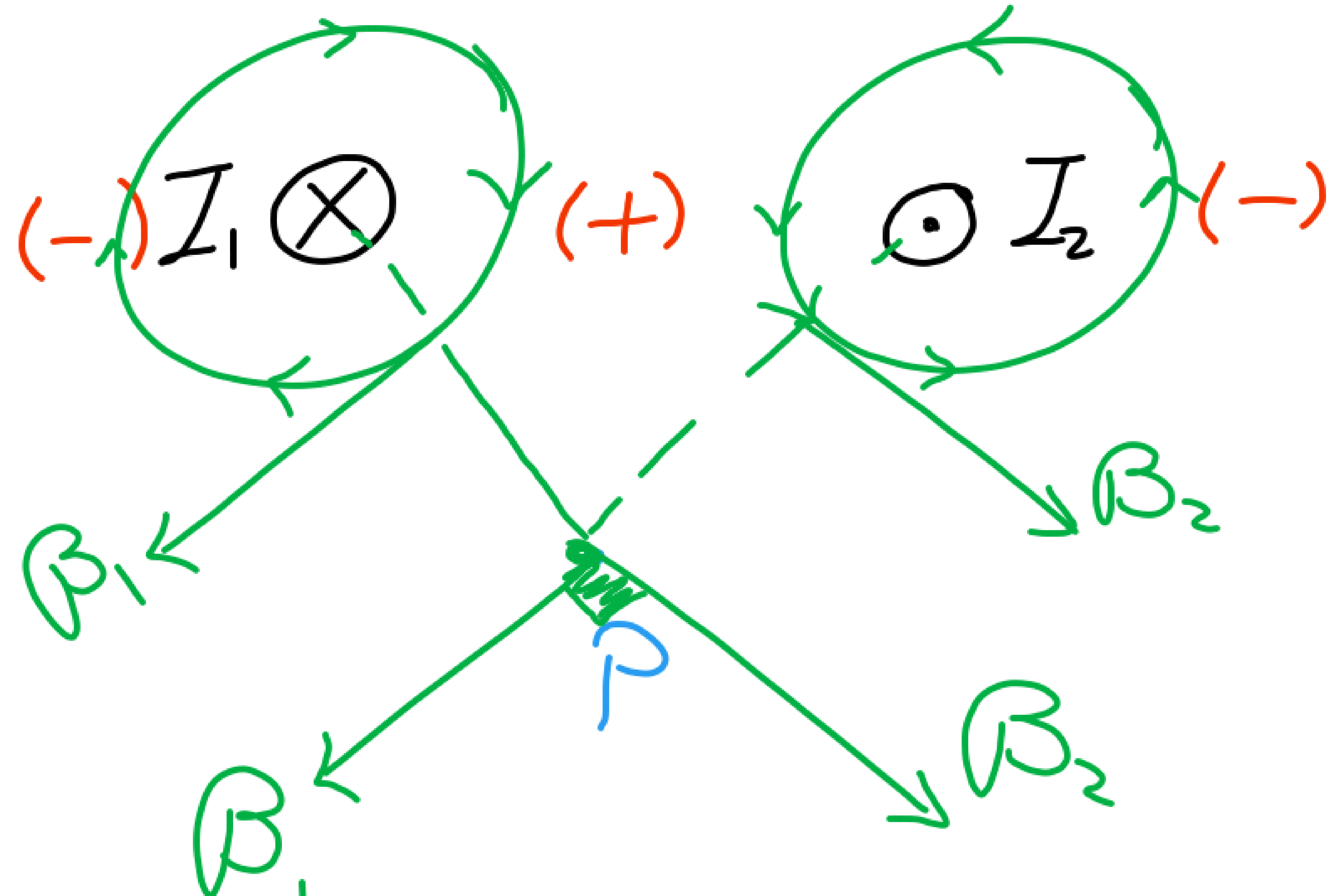


→ Non-Coplanar



$$\boxed{B_T = \sqrt{B_1^2 + B_2^2}}$$





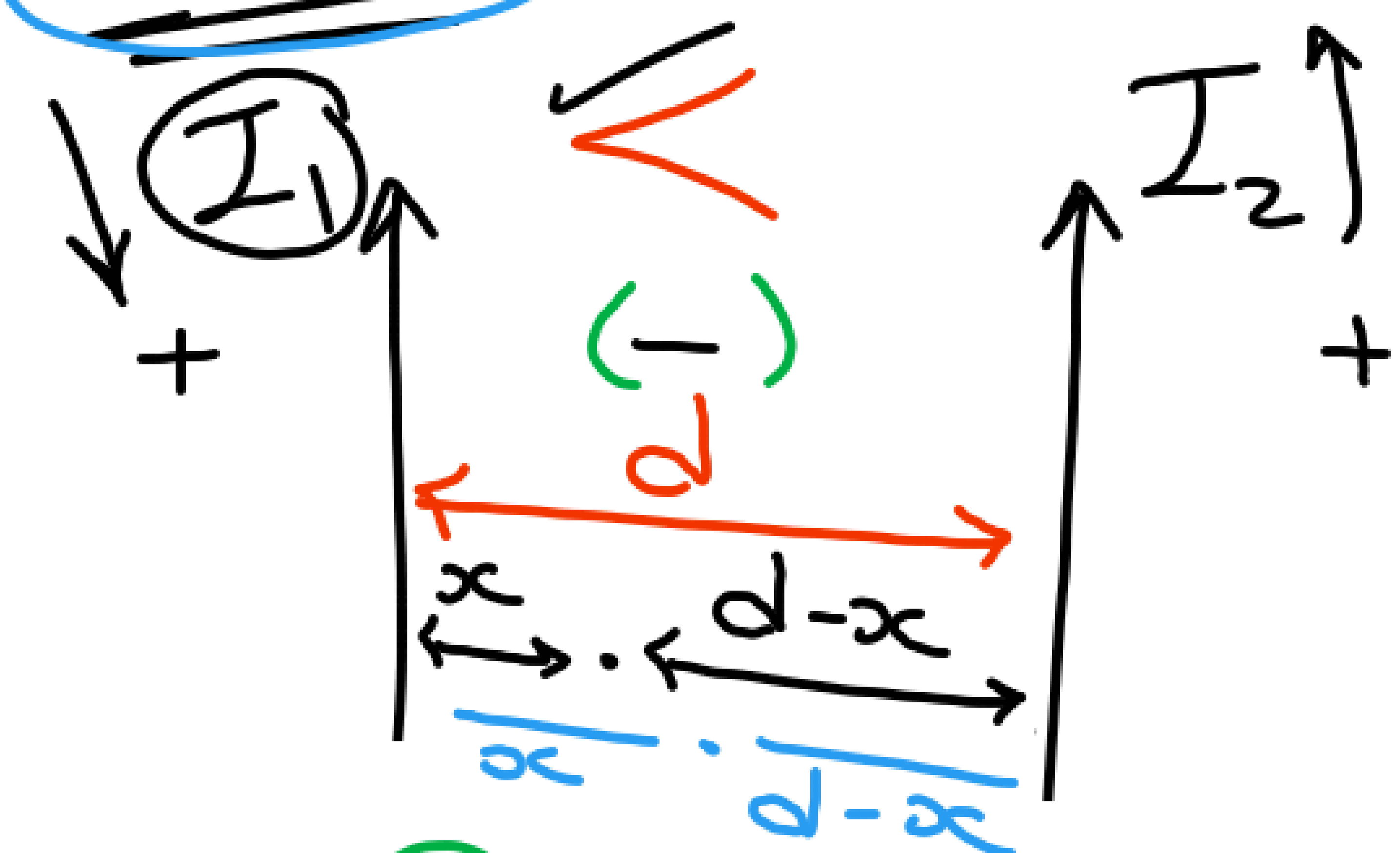
$$\boxed{B_T = \sqrt{B_1^2 + B_2^2}}$$

→ Neutral point → $B_T = 0$

Opp MF (−)

near the weaker current

Same



$B_T = 0$

$B_1 - B_2 = 0$

$B_1 = B_2$

~ if $I_1 = I_2$

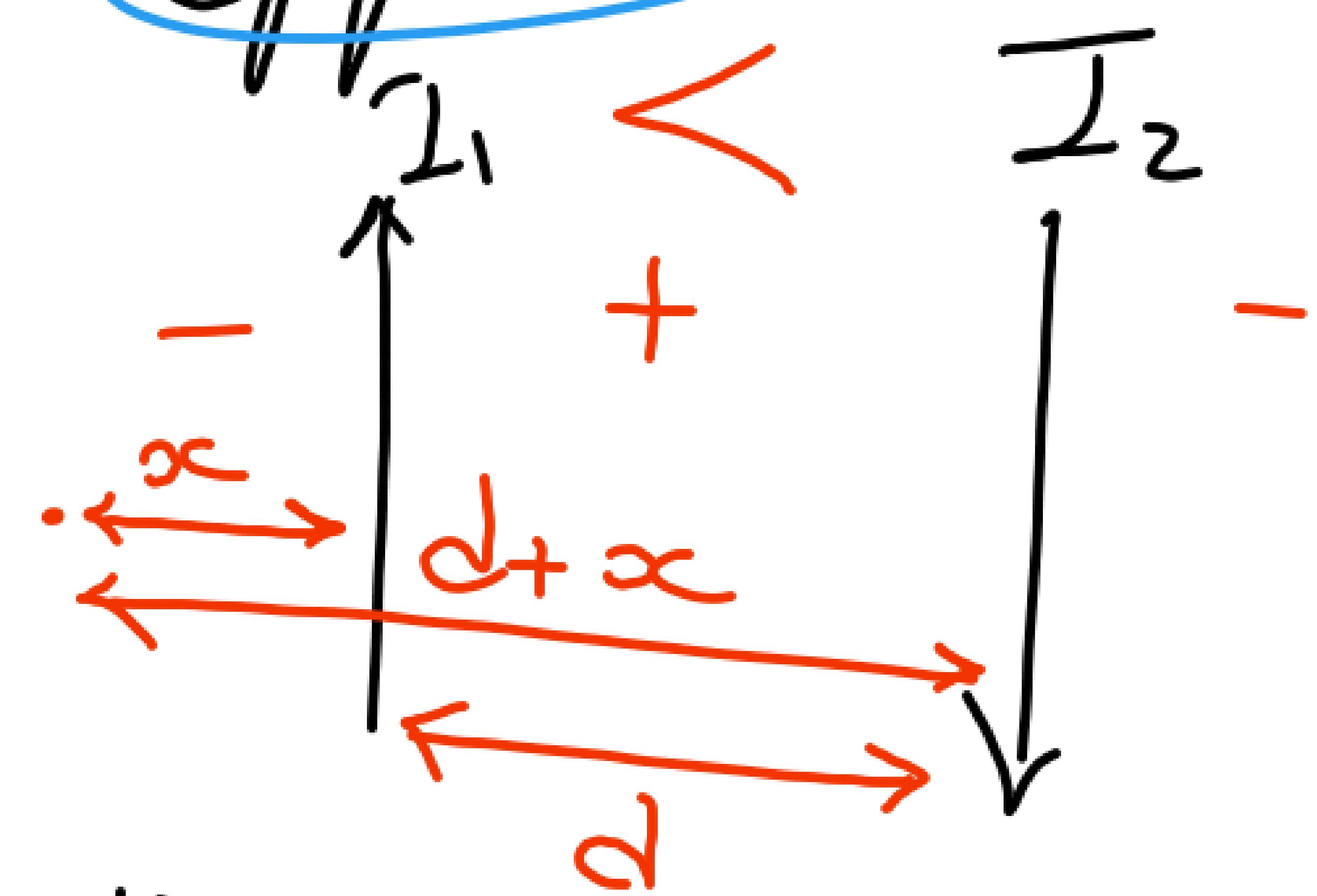
$x = d - x$

∴ Neutral at midpoint

$$\frac{\cancel{2\times10^{-7}}\, I_1}{d_1} = \frac{\cancel{2\times10^{-7}}\, I_2}{d_2}$$

$$\boxed{\frac{I_1}{x} = \frac{I_2}{d-x}}$$

Opposite



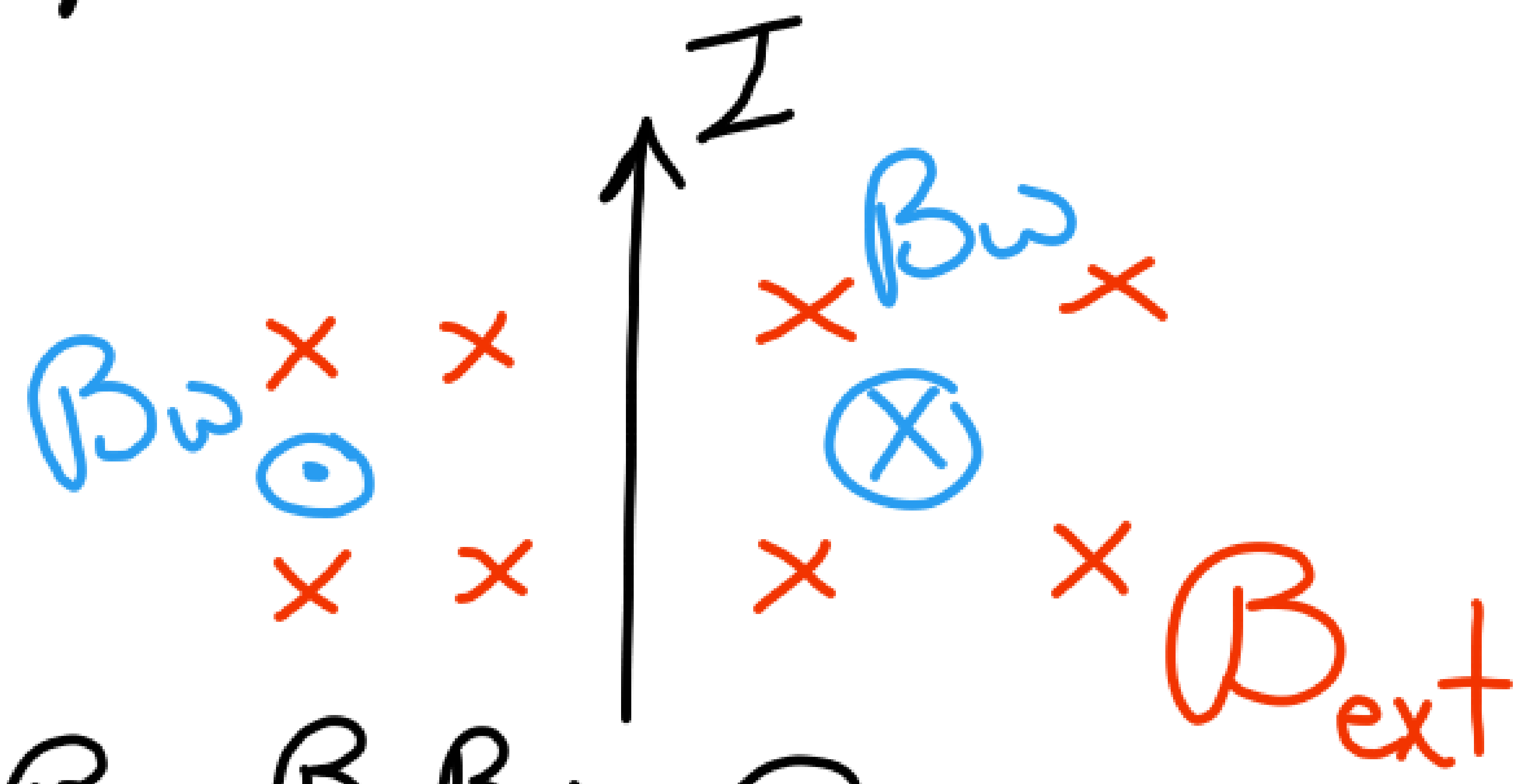
$$\boxed{\frac{I_1}{x} = \frac{I_2}{d+x}}$$

if $I_1 = I_2$

∴ $x \neq d + x$

∴ No neutral point.

$\boxed{4}$ Wire + MF



$B_T = B_w - B_{ext}$ or $= B_{ext} - B_w$

$B_T = B_w + B_{ext}$

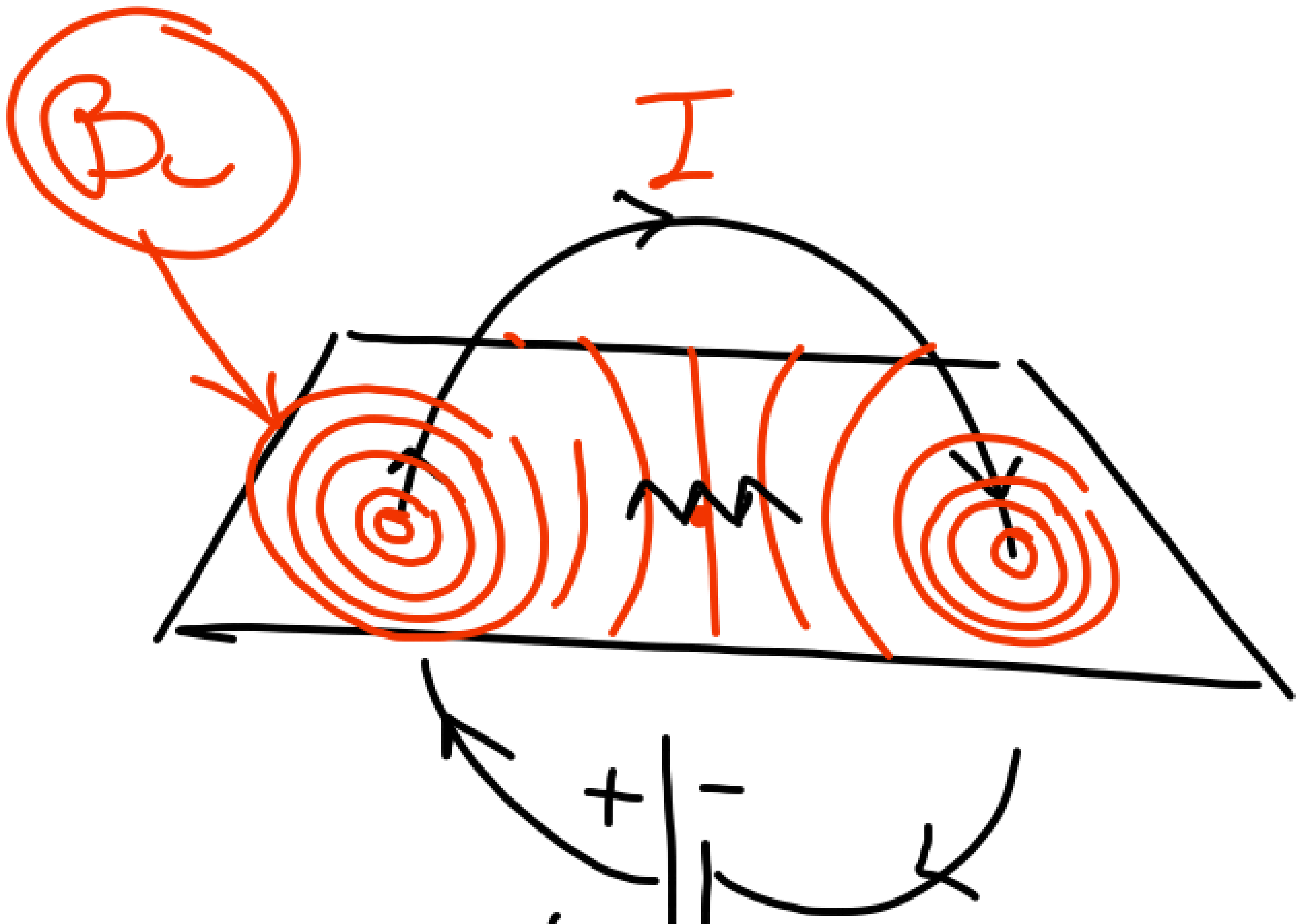
$\boxed{B_A, B_B} > B_C, B_D$

$\therefore d_B < d_A$

$\boxed{\therefore B_B > B_A}$

$\boxed{2}$ Circular Coil

a) Shape



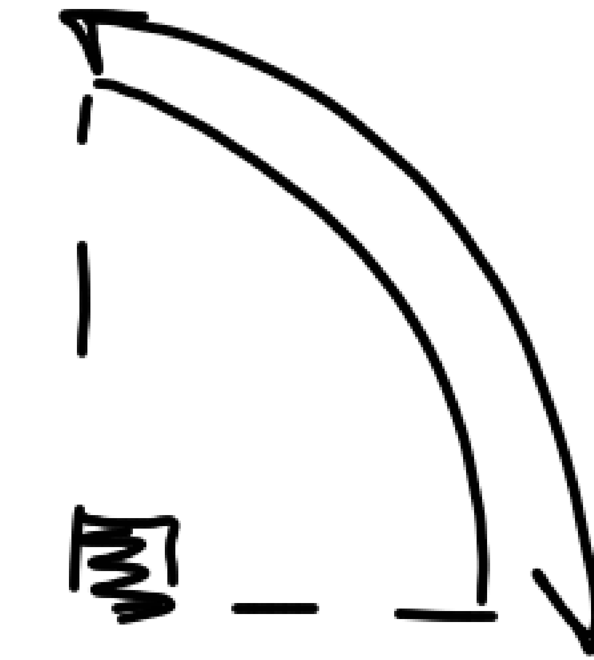
→ properties:

1) Concentric X
2) Uniform parallel

b) Law:

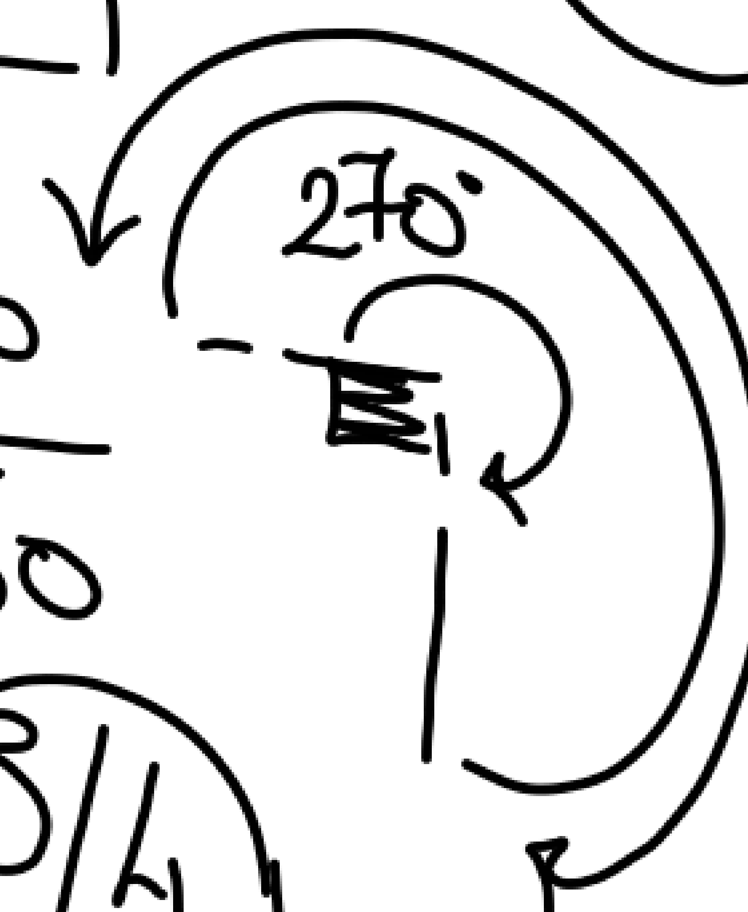
$$\boxed{B_c = \frac{\mu N I}{2r}}$$

$$\boxed{N = \frac{L_{wire}}{2\pi r} = \frac{\theta}{360^\circ}}$$



$$N = \frac{90}{360} = \frac{1}{4}$$

$$N = \frac{270}{360} = \frac{3}{4}$$



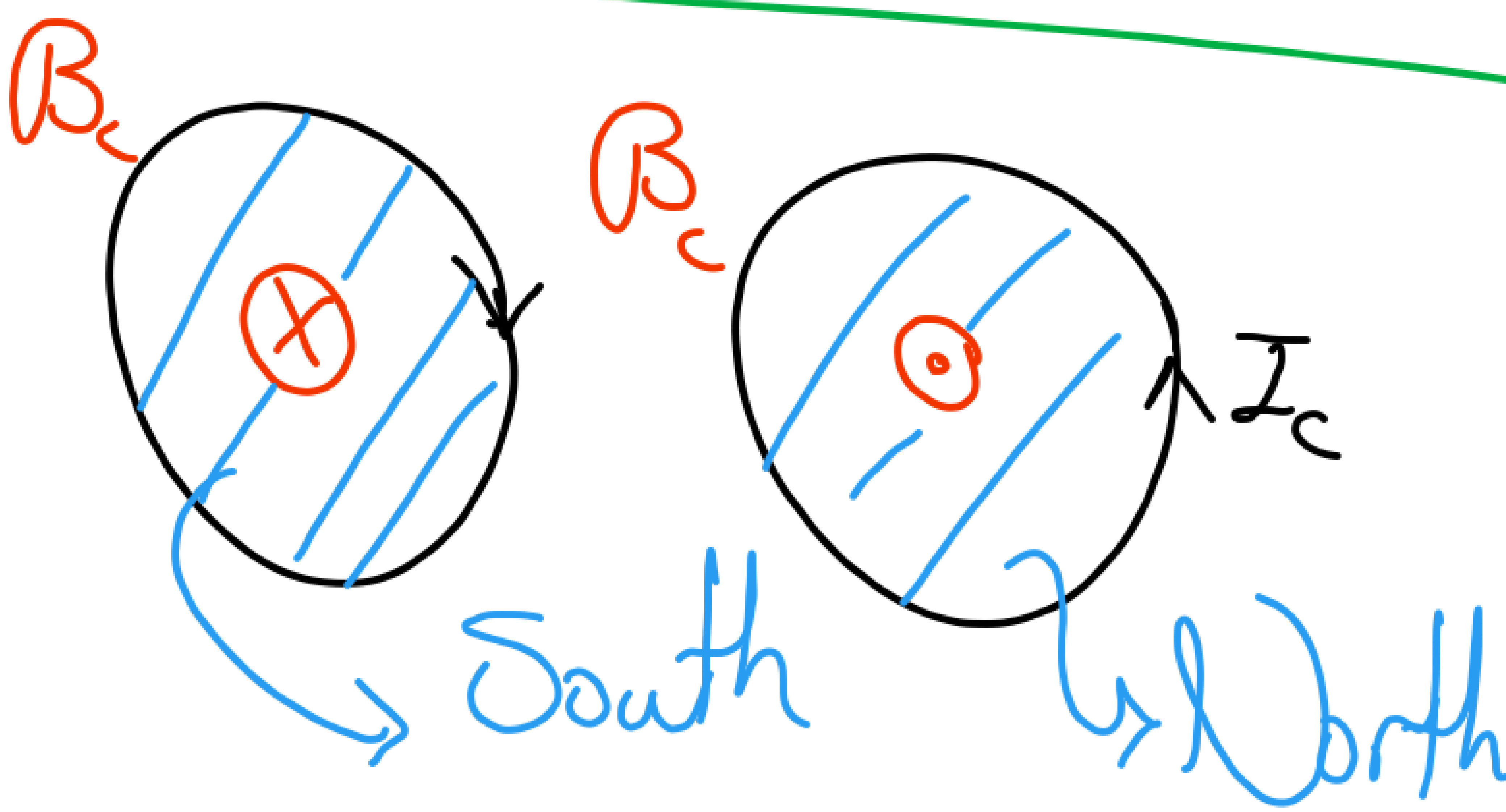
3) M. flux ⊥ coil's plane
4) Very similar to short bar magnet

c) Directions:

R.H.S.R:

Clockwise $\otimes$ South

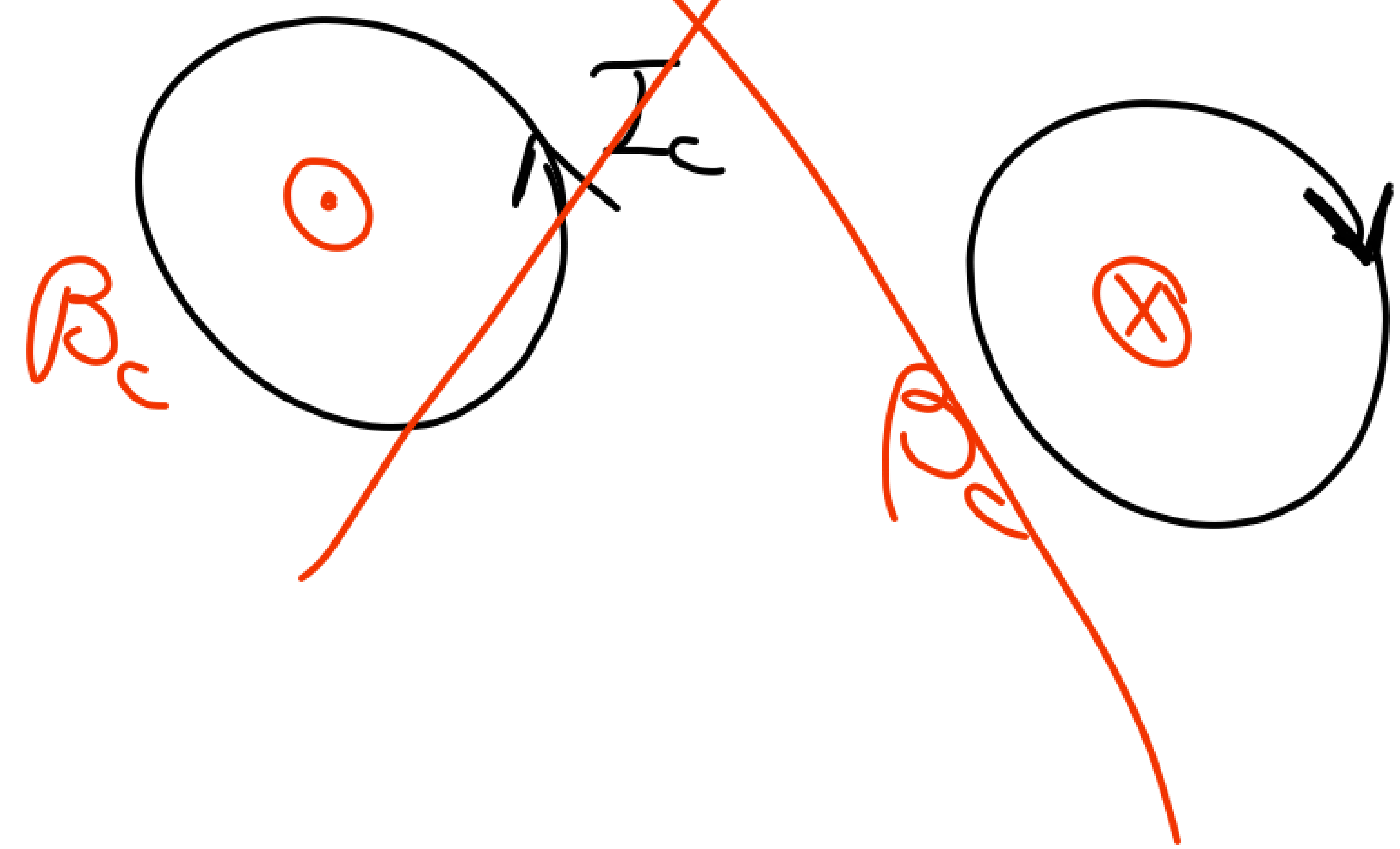
Anticlockwise $\odot$ North



~~→ **A.R.H.R:**~~

~~Fingers → Current~~

~~Thumb → MF~~

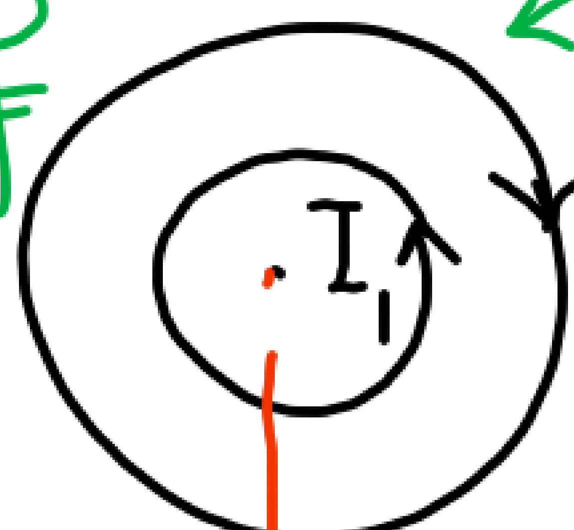


Problems:

1 Concentric Coils

Coplanar

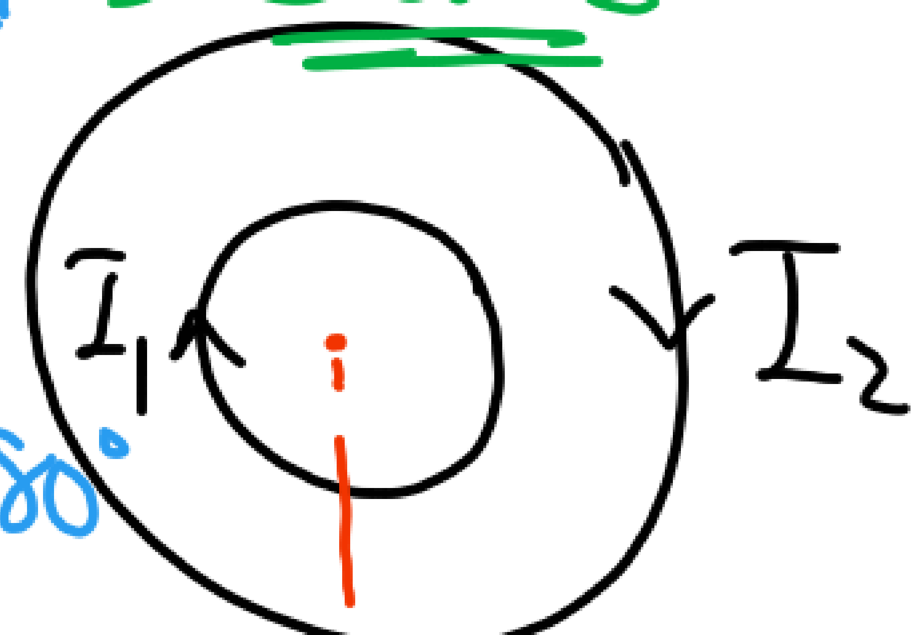
Opp | Overturned / Reversed / Flipped / Inverted / Rotated 180° | Same



B_1 ⊙ ⊗ B_2

$$\boxed{B_T = B_1 - B_2 \quad \underline{\text{or}} \quad B_2 - B_1}$$

(opp) [illegible]

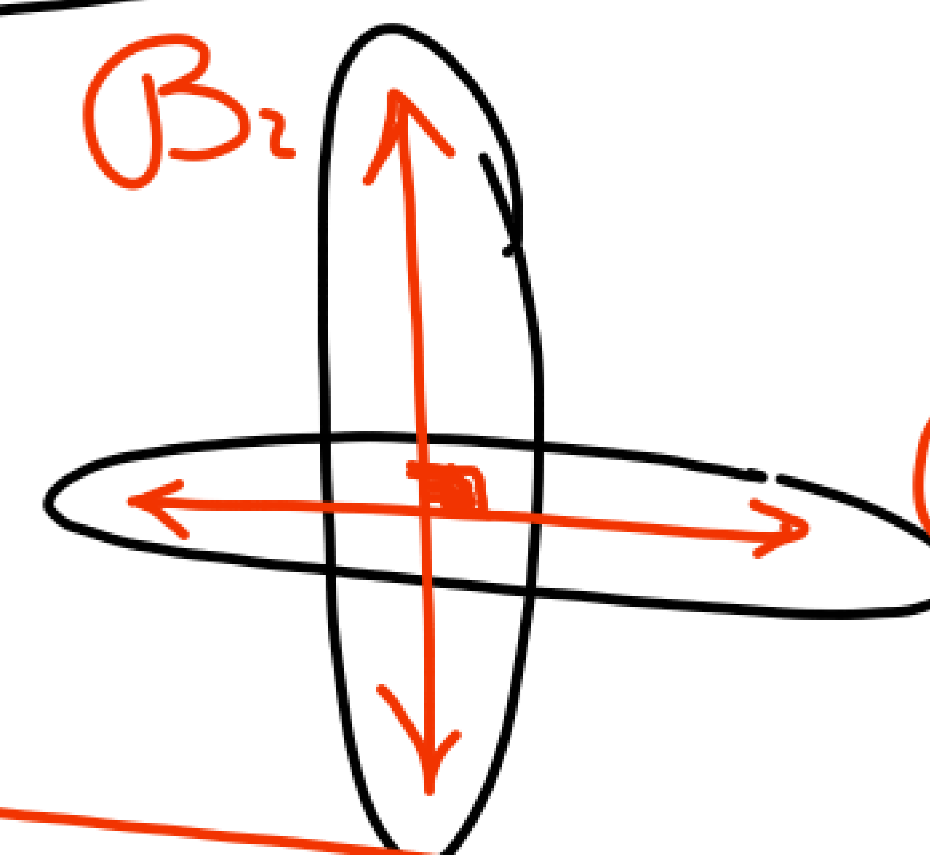


B_1 ⊗ ⊗ B_2

$$\boxed{B_T = B_1 + B_2}$$

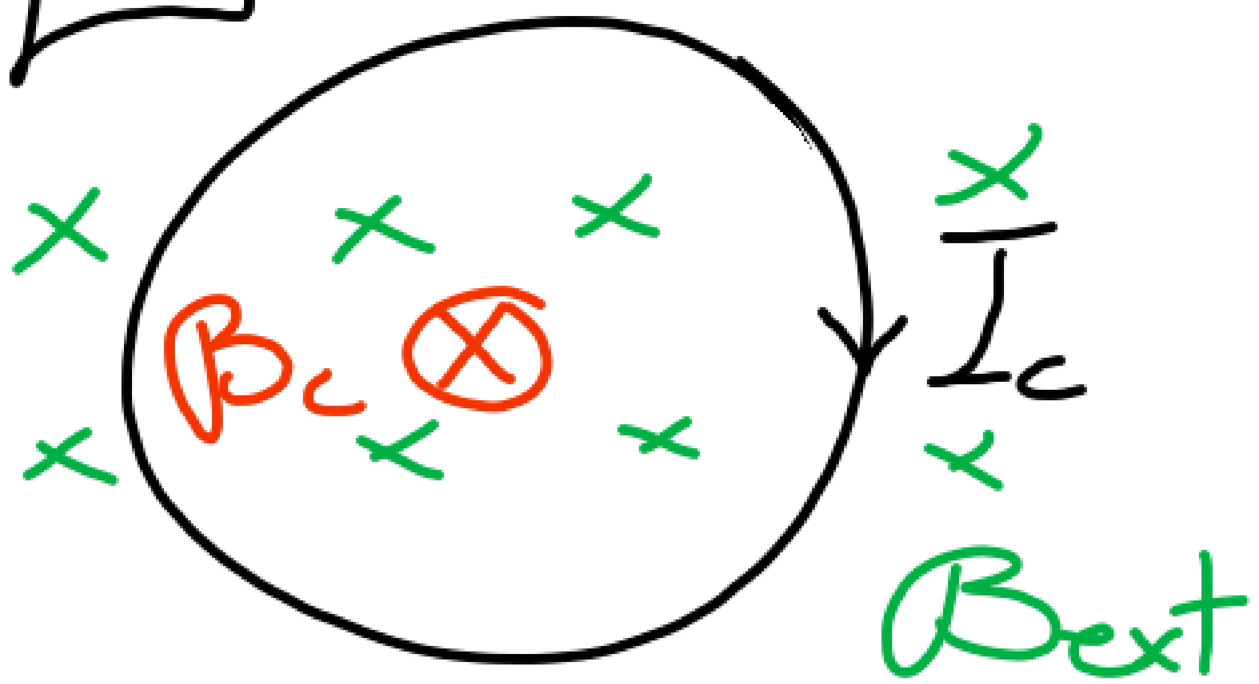
Same (+) لو كانوا

Non-Coplanar

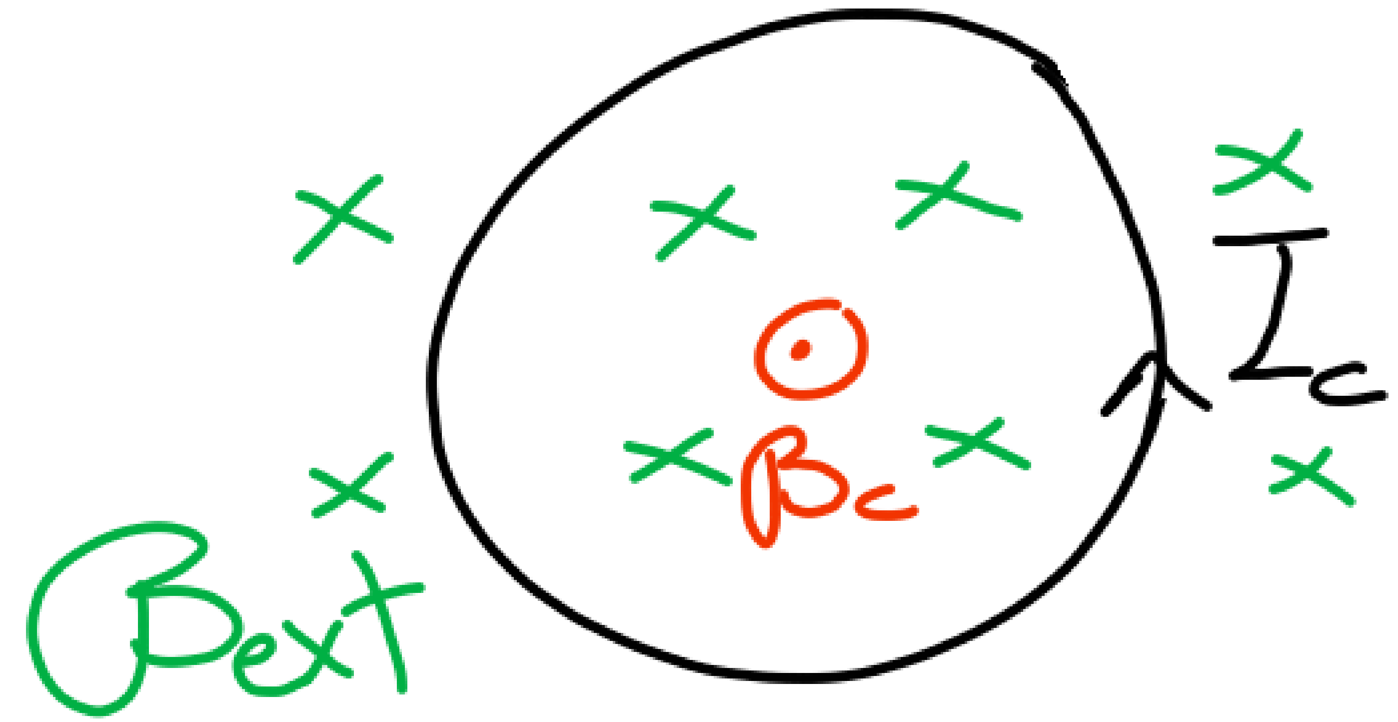


$$\boxed{B_T = \sqrt{B_1^2 + B_2^2}}$$

2 Coil + External MF



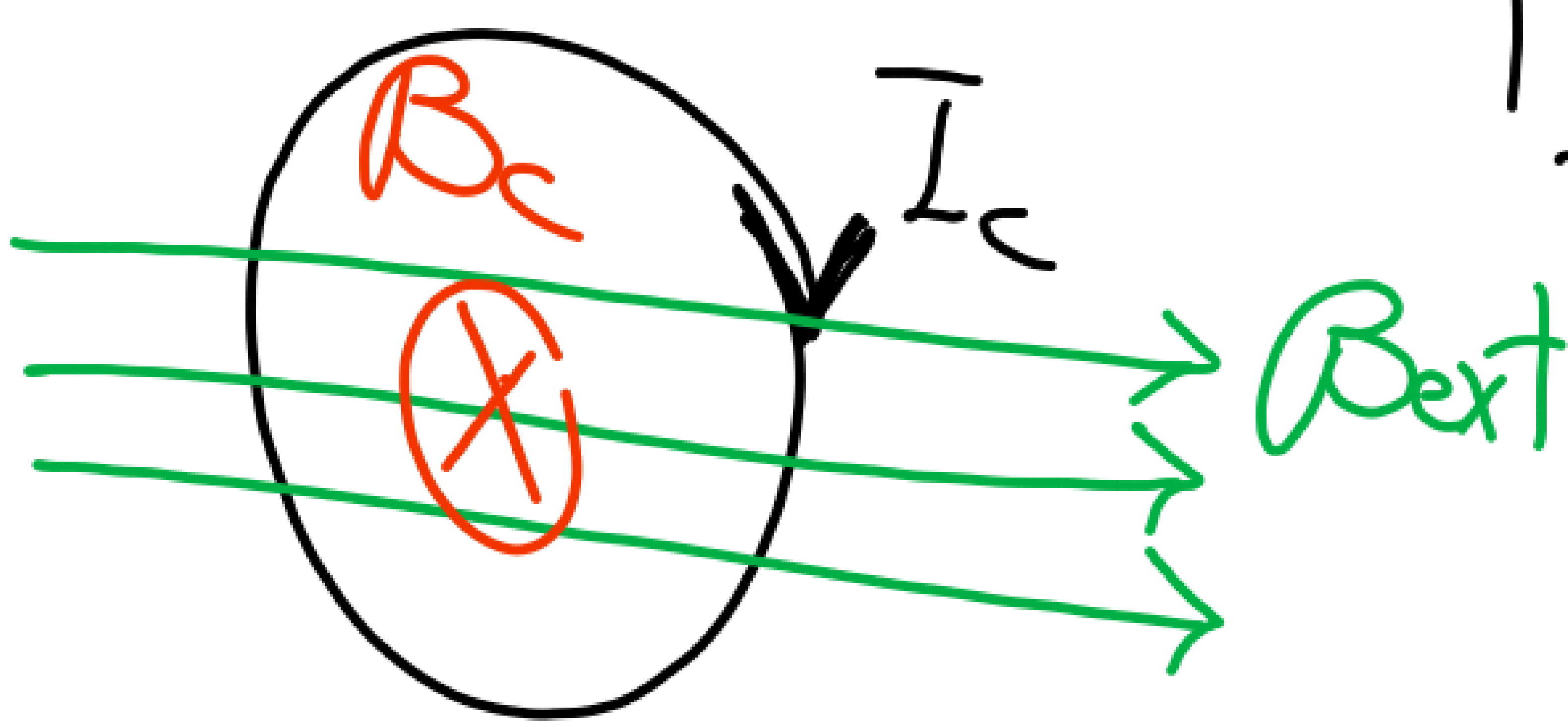
$$B_T = B_c + B_{ext}$$



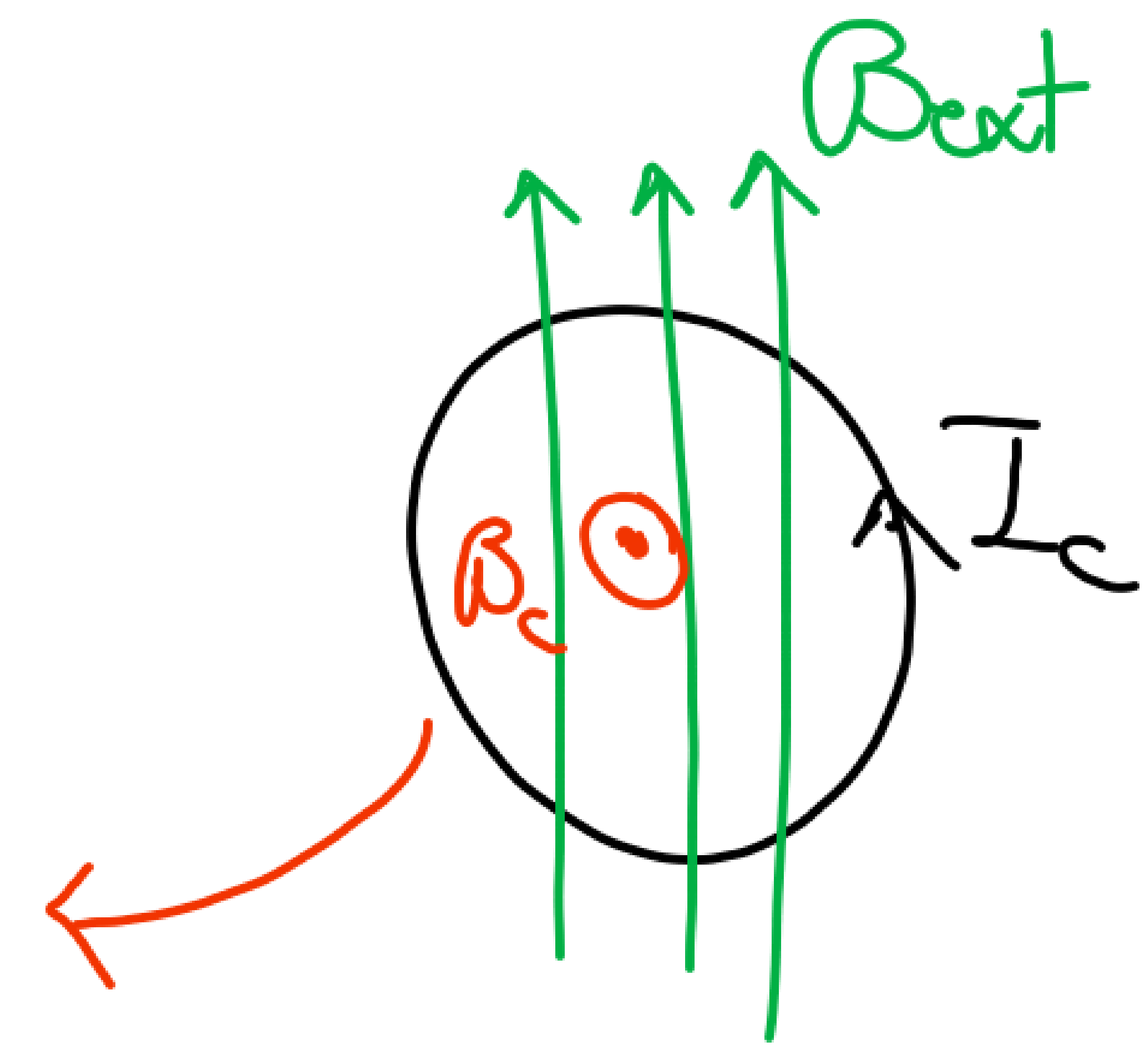
$$B_T = B_c - B_{ext}$$

or

$$B_{ext} - B_c$$



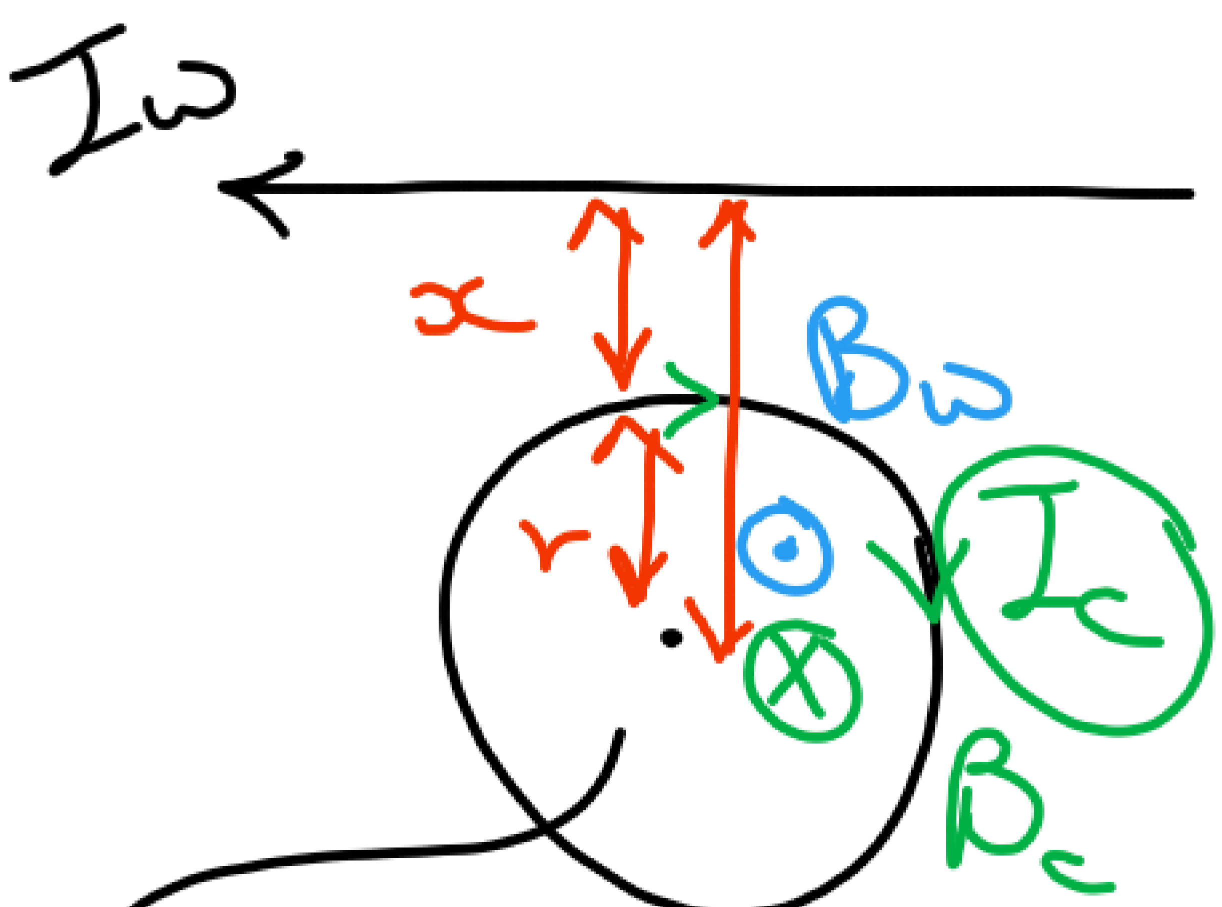
$$B_T = \sqrt{B_c^2 + B_{ext}^2}$$



3 Coil + Wire

a) Not Tangent

$(d \neq r)$



$$\boxed{B_T = 0}$$

$$B_c - B_w = 0$$

$$B_c = B_w$$

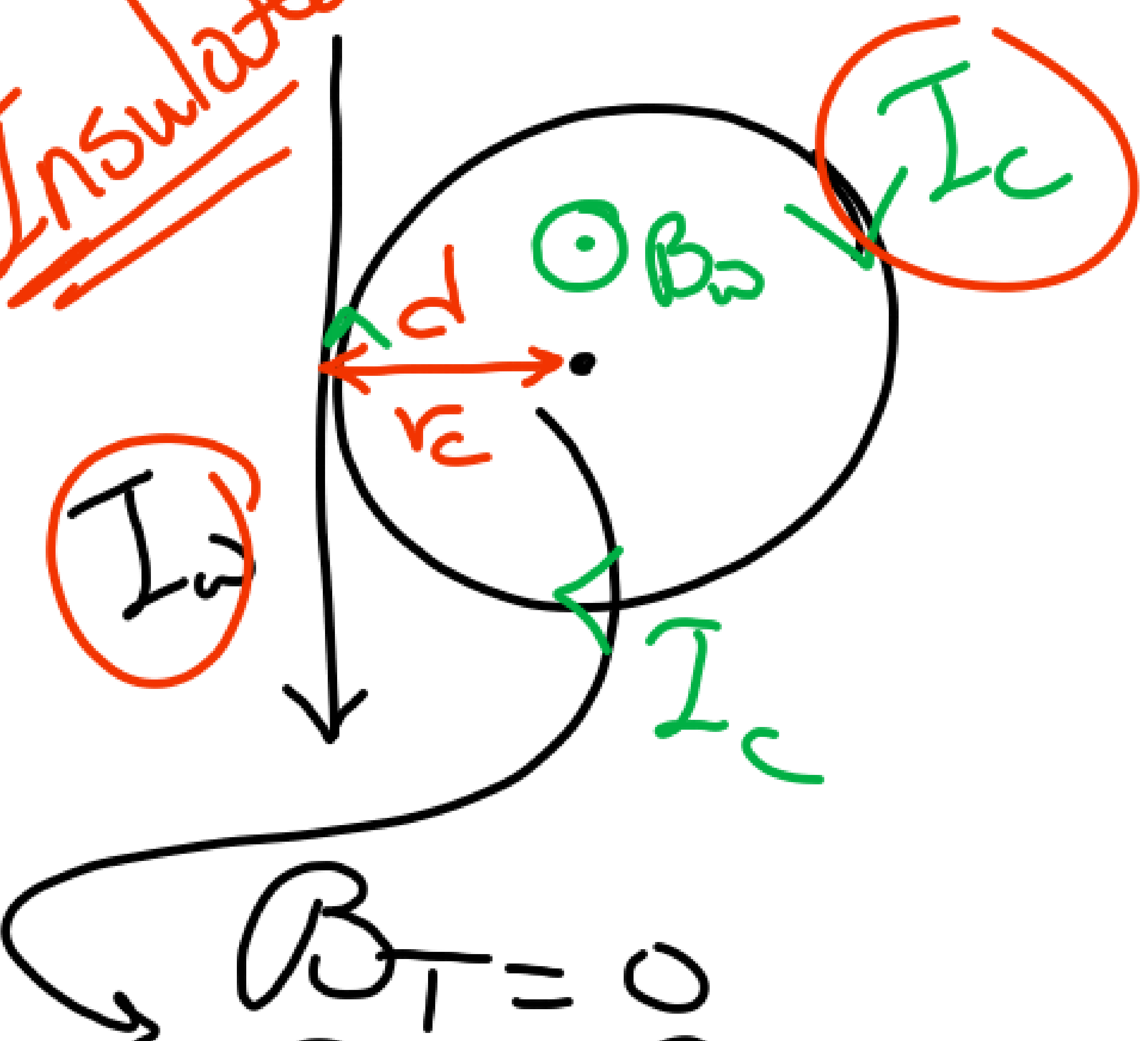
$$\frac{\cancel{\mu} N_c I_c}{\cancel{2} r_c} = \frac{\cancel{\mu} I_w}{\cancel{2}\pi d}$$

$$\frac{N_c I_c}{r_c} = \frac{I_w}{\pi d}$$

$$* \boxed{\frac{N_c I_c}{r_c} = \frac{I_w}{\pi (r_c + x)}}$$

b) Tangent

$(d = r)$

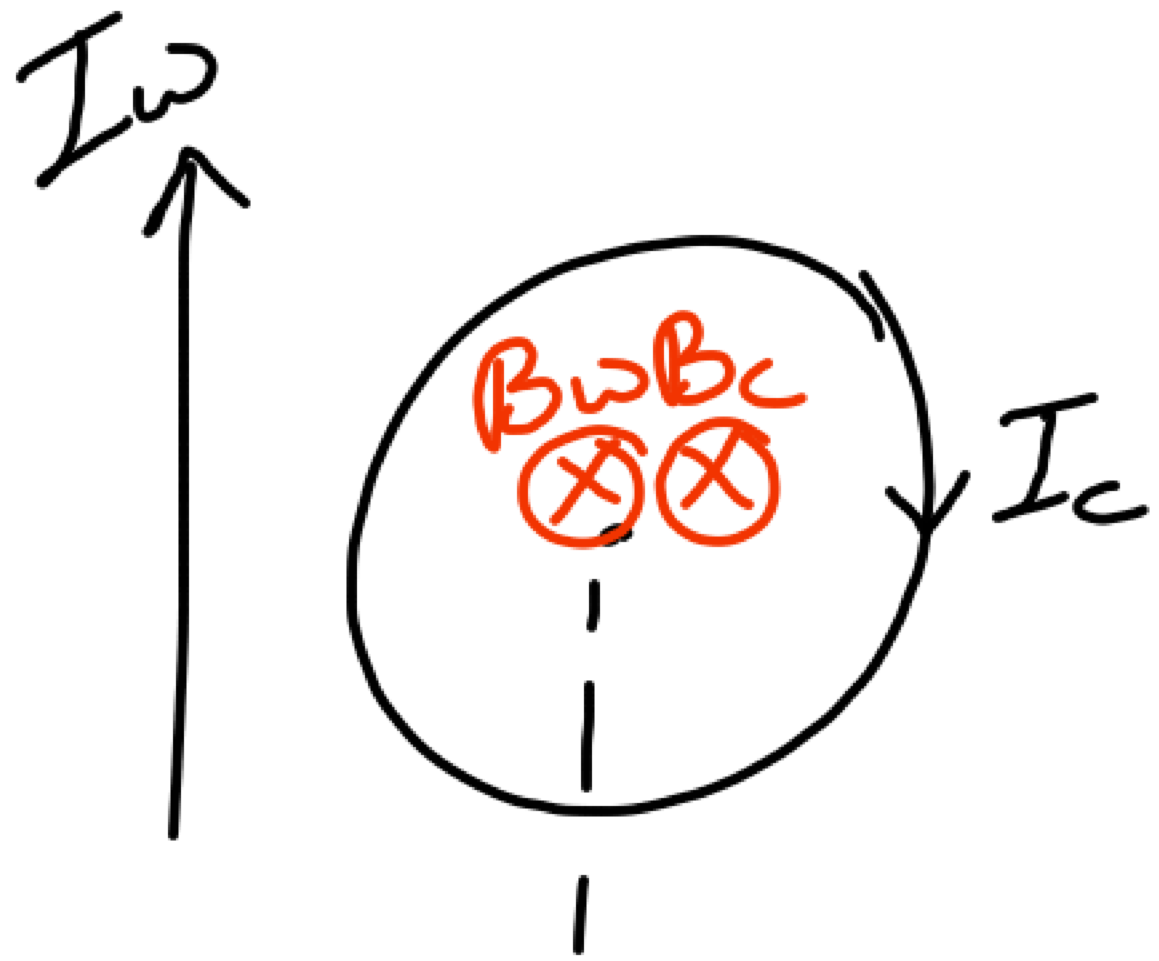


$$B_T = 0$$

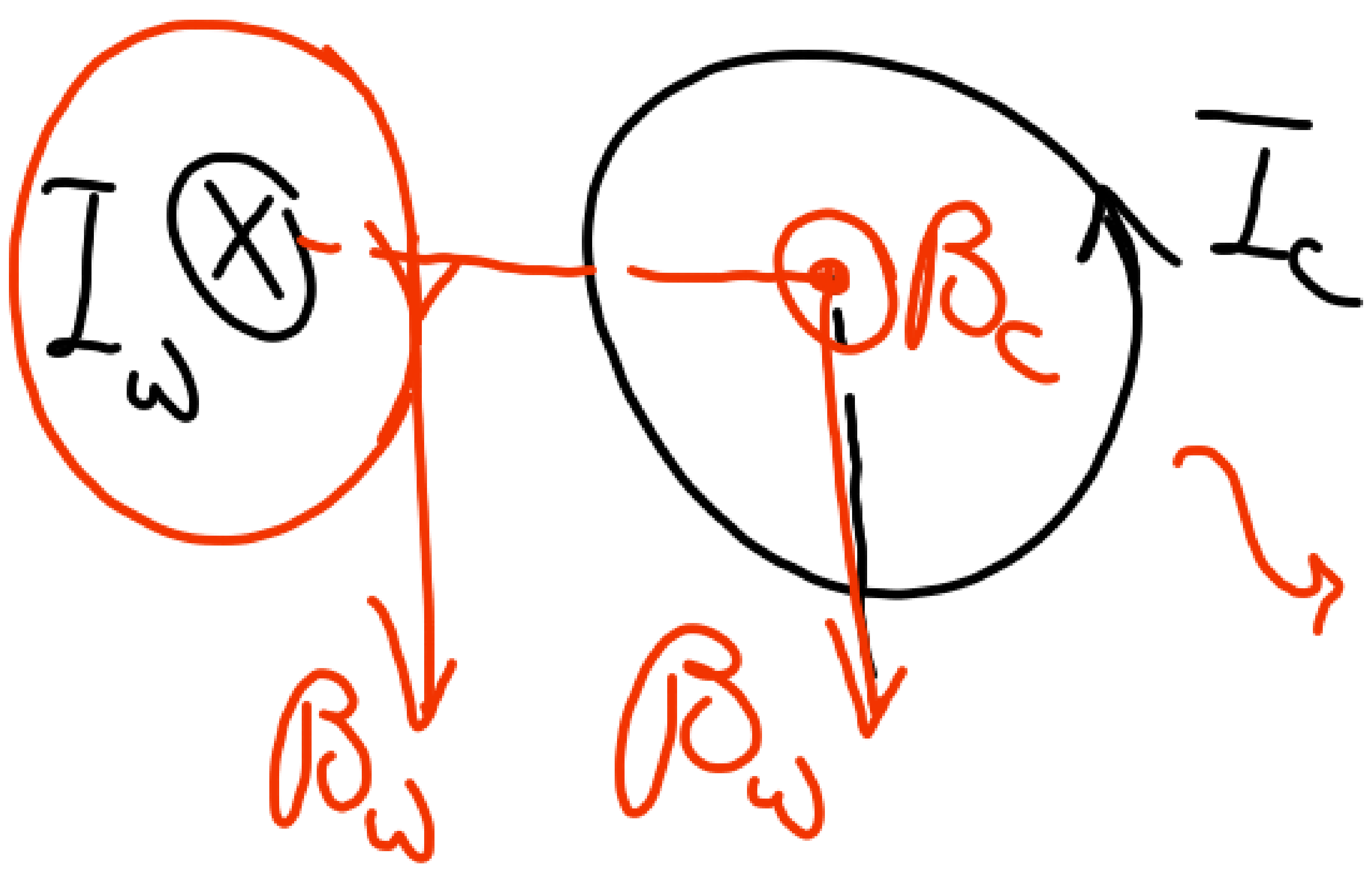
$$B_w = B_c$$

$$\frac{\cancel{\mu}}{\cancel{2}\pi} \frac{I_w}{\cancel{d}} = \frac{\cancel{\mu} N_c I_c}{\cancel{2 r_c}}$$

$$* \boxed{\frac{I_w}{\pi} = N_c I_c}$$

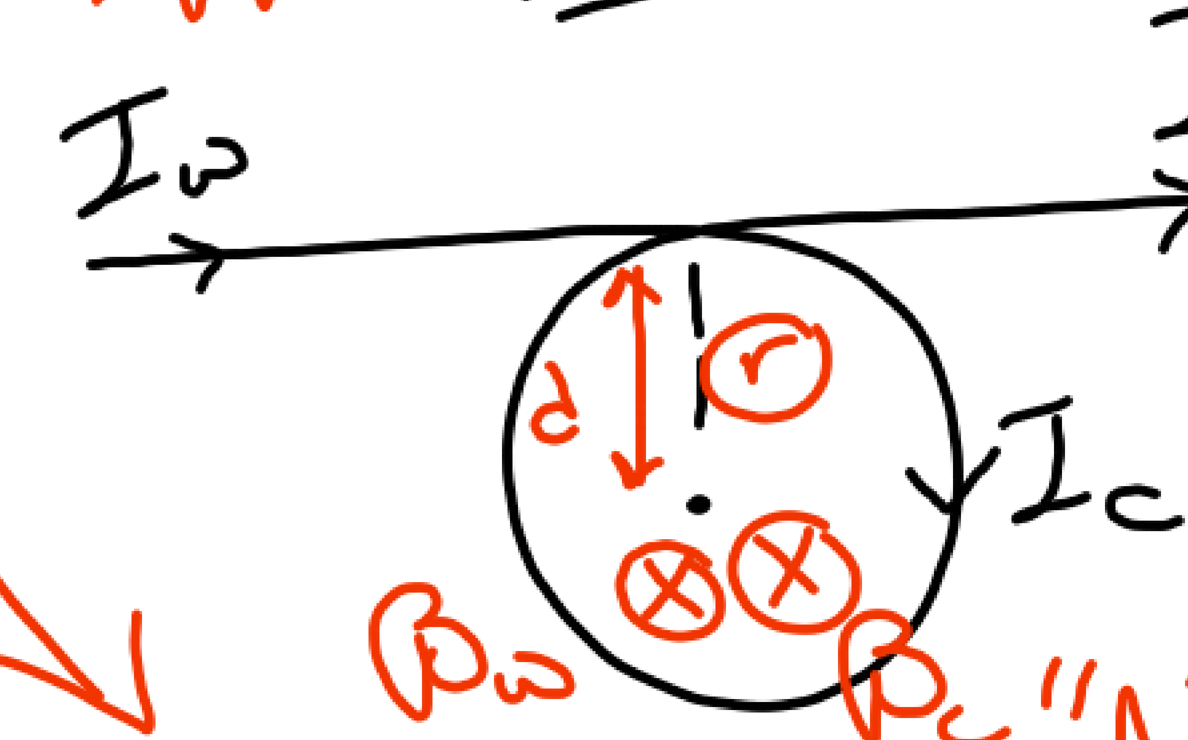


$$\boxed{B_T = B_w + B_c}$$



$$\boxed{B_T = \sqrt{B_w^2 + B_c^2}}$$

Wire "tangent" bent to form coil



"Not insulated"

$$\boxed{\begin{aligned} I_w &= I_c \\ d &= r \end{aligned}}$$

$$\boxed{B_T = B_w + B_c}$$

دايما الشي بيجمعوا

same (+)

4 Ratio

a) Coil unwound then again rewounded

"Reshaped" "Recoiled"

$$B = \frac{\mu N I}{2r} \rightarrow \frac{B_1}{B_2} = \frac{N_1 \cancel{I_1} r_2}{N_2 \cancel{I_2} r_1}$$

$\therefore L_{wire}, I$ are const.

$$\frac{B_1}{B_2} = \frac{N_1 r_2}{N_2 r_1} \qquad N = \frac{\cancel{L_{wire}}}{2\pi r}$$

$$\boxed{\frac{B_1}{B_2} = \frac{N_1^2}{N_2^2}} \qquad \boxed{\frac{B_1}{B_2} = \frac{r_2^2}{r_1^2}} \qquad \boxed{\frac{N_1}{N_2} = \frac{r_2}{r_1}}$$

b) Coil turns

{Cut, Removed / Added, Extra wire}?

"Keeping radius const"

$$\frac{B_1}{B_2} = \frac{N_1 I_1 \cancel{r_2}}{N_2 I_2 \cancel{r_1}}$$

$N \downarrow L_w \downarrow R \downarrow I \uparrow$

$$\boxed{\frac{N_1}{N_2} = \frac{I_2}{I_1}}$$

Same Battery

V const. $\rightarrow$ $V = IR$

$$\frac{B_1}{B_2} = \frac{\cancel{I_2} \cancel{I_1}}{\cancel{I_1} \cancel{I_2}} = \boxed{1}$$

Unchanged

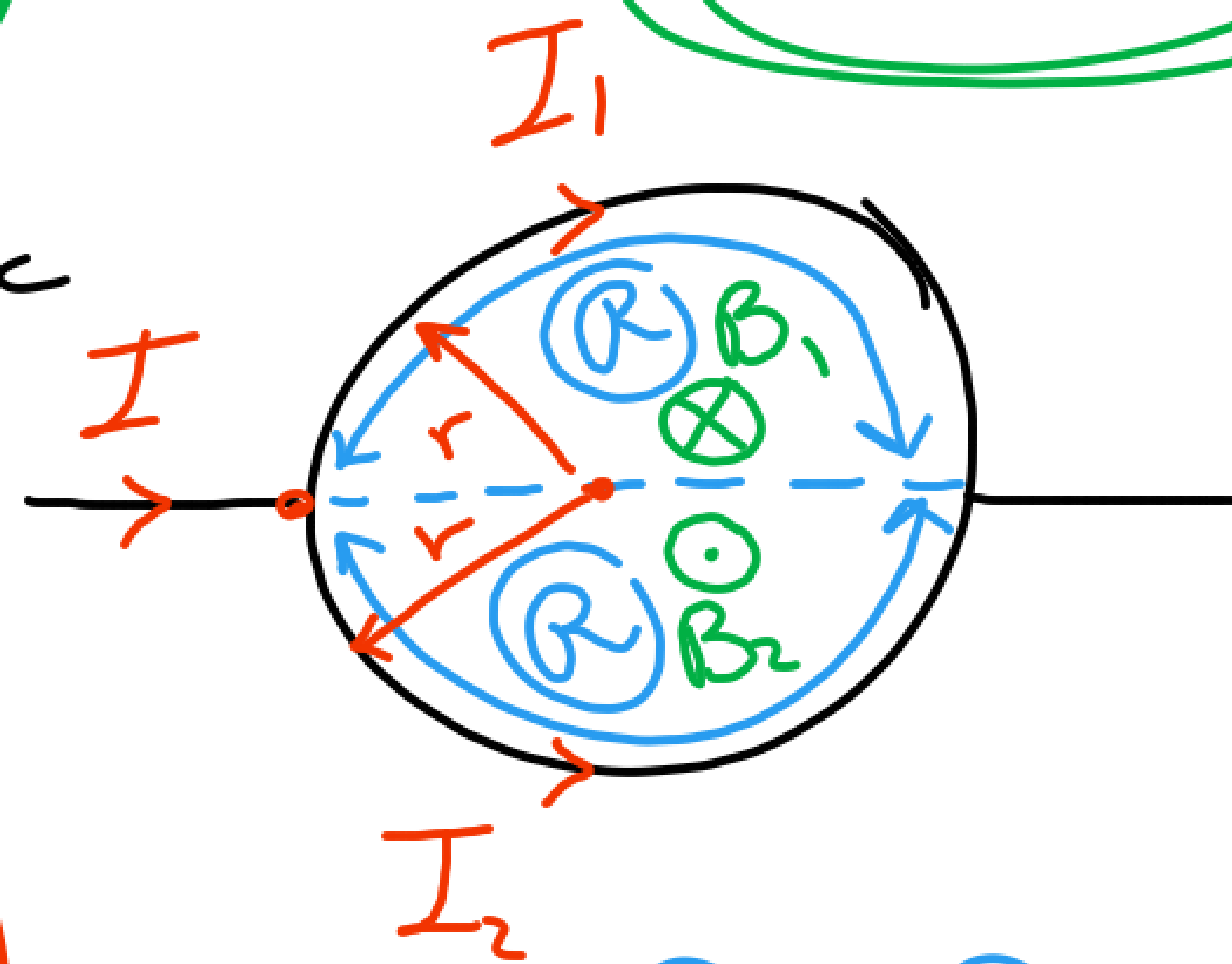
Same Current

I const.

$$\boxed{\frac{B_1}{B_2} = \frac{N_1}{N_2}}$$

5 Ring → $B_T = 0$

$$\boxed{B_c = \frac{\mu N I}{2r}}$$



$\therefore R_1 = R_2 = R$

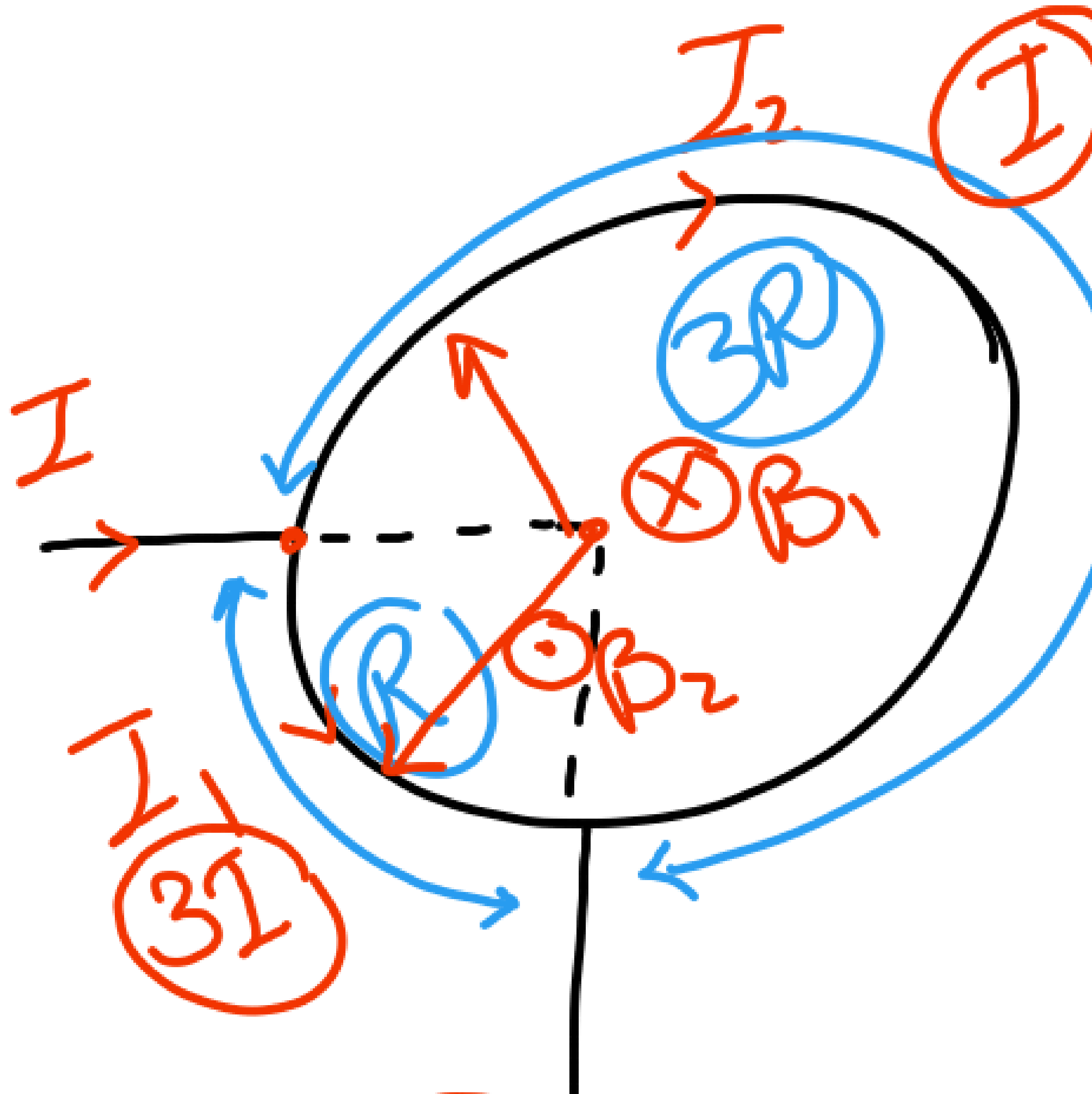
$\therefore I_1 = I_2$

$N_1 = 1/2 \quad N_2 = 1/2$

$r_1 = r_2$

$\therefore B_1 = B_2$ "opp"

$$\boxed{B_T = B_1 - B_2 = zero}$$



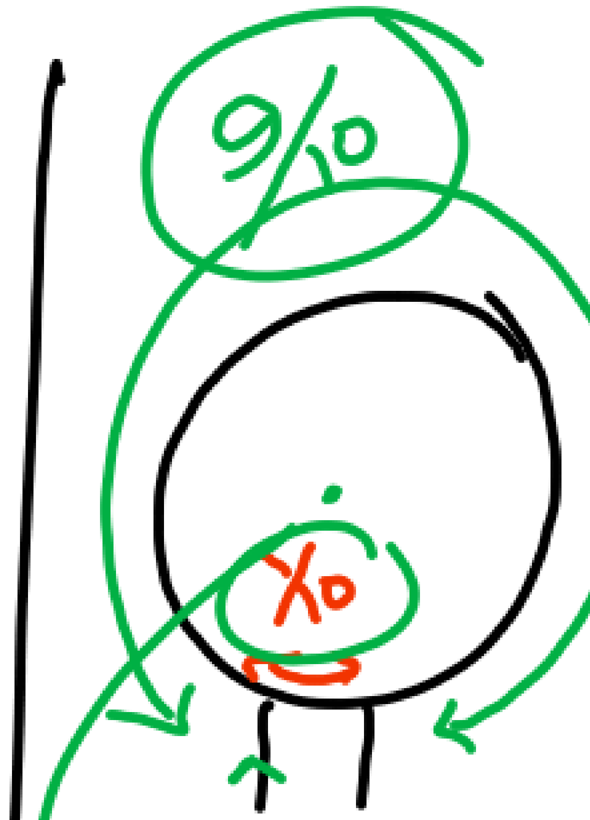
$N_1 = 1/4 \quad N_2 = 3/4$

$I_1 = 3I \quad I_2 = I$

$r_1 = r_2$

$\therefore B_1 = B_2$ "opp"

$$\boxed{\therefore B_T = 0}$$



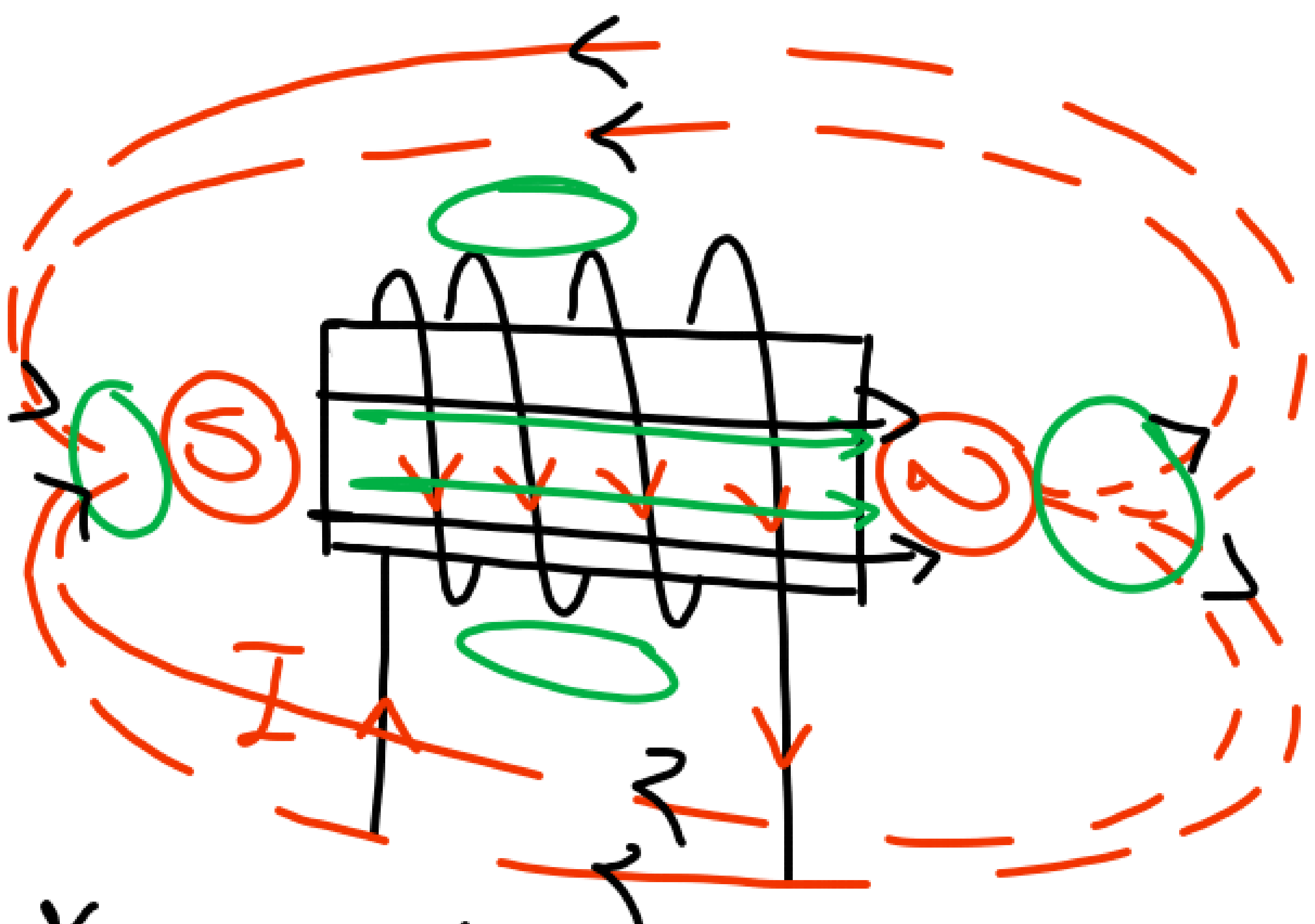
$$\boxed{B_T = 0}$$

$B_1 = B_2$

"opp"

3 Solenoid

a) Shape



*properties:

1) Bar magnet
2) Form closed paths
3) Emerges from N → S

b) Law:

$$\boxed{B_s = \frac{\mu N I}{L_s}}$$

or

$$\boxed{B_s = \mu n I}$$

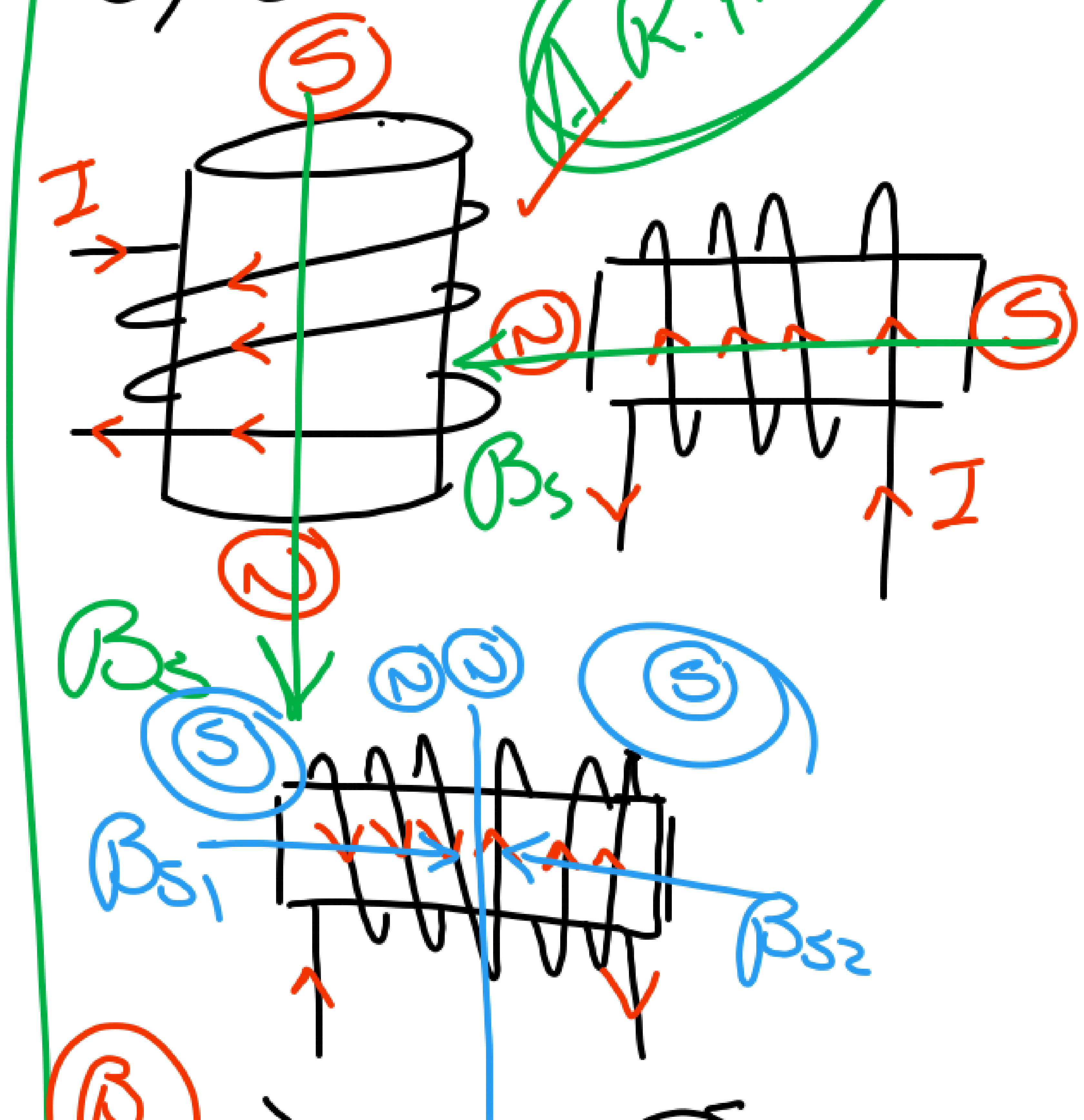
n: No. of turns per unit length

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

$$\frac{N}{cm} \xrightarrow[\cancel{\times 10^{-2}}]{\cancel{\times 1}} \frac{N}{m} \qquad \boxed{\times 10^{2}}$$

c) Direction:

R.H.R

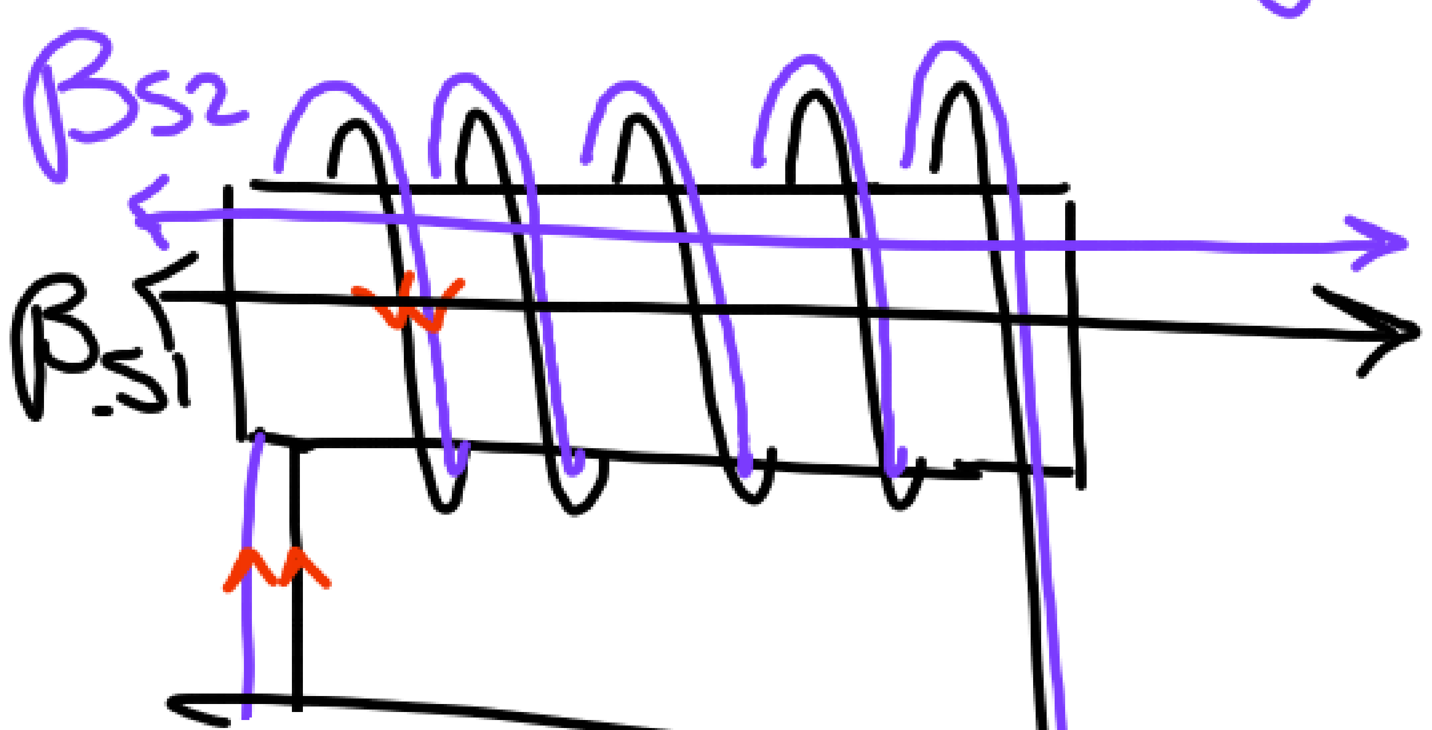


$\boxed{\text{R.H.S.R}}$

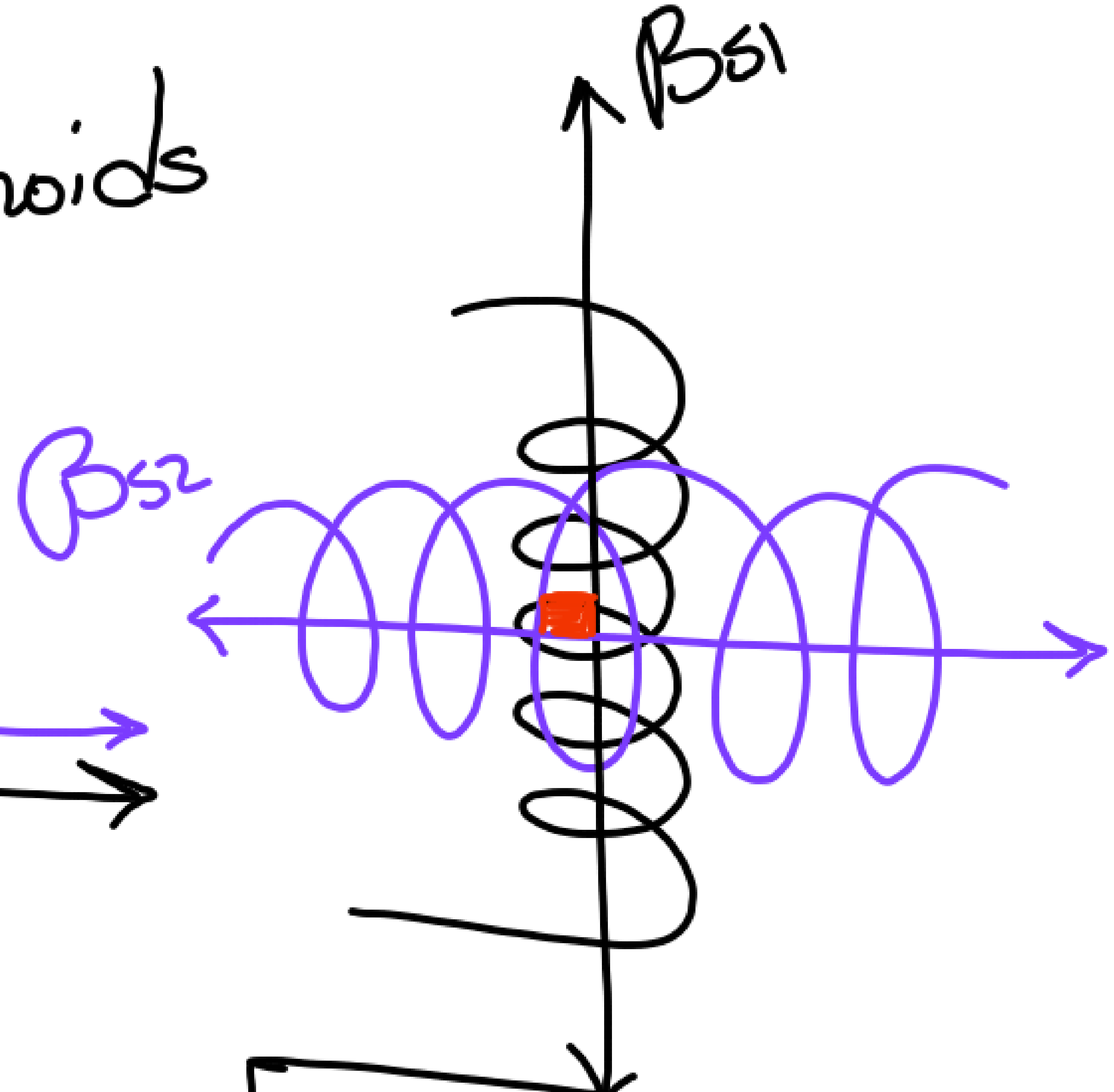
Problems:

1 Two Solenoids

Co-axial

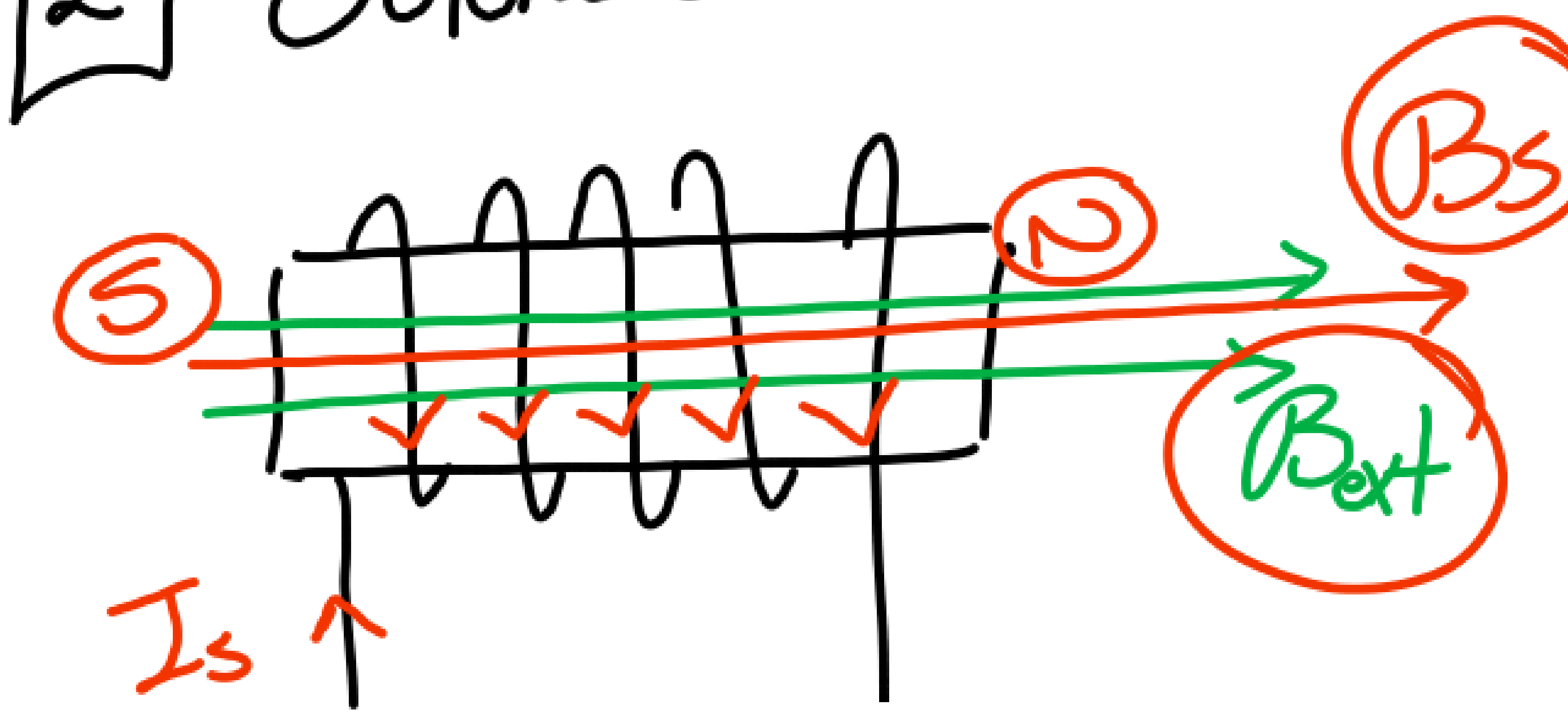


$$\boxed{B_T = B_{S1} \pm B_{S2}}$$

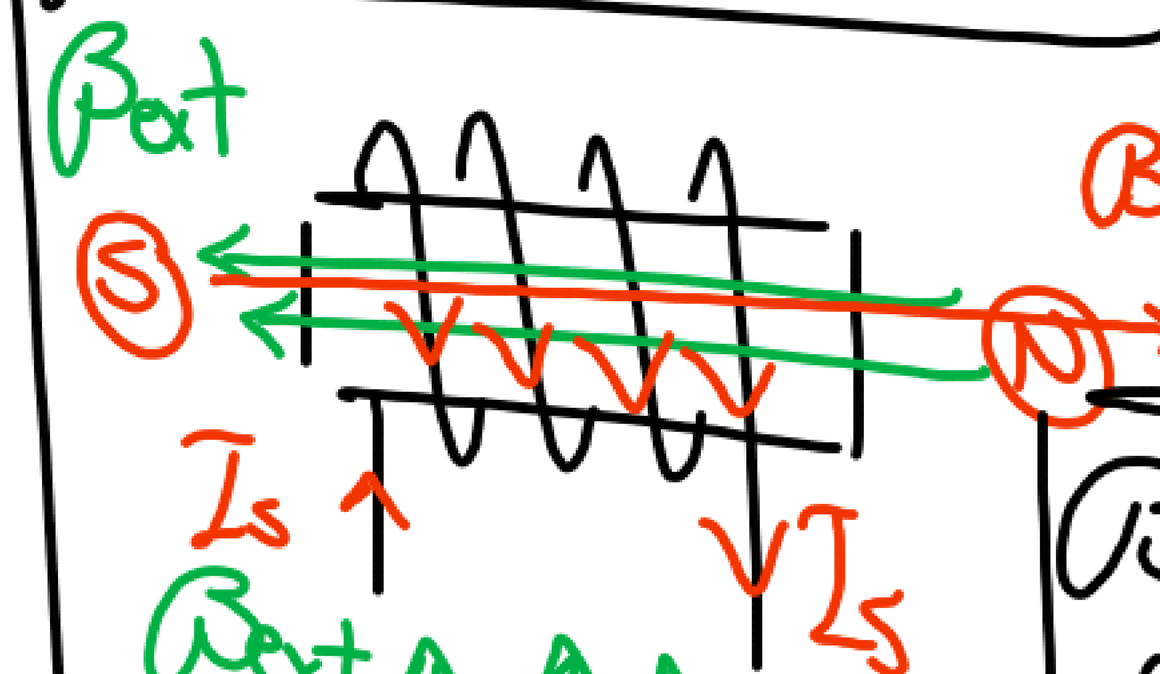


$$\boxed{B_T = \sqrt{B_{S1}^2 + B_{S2}^2}}$$

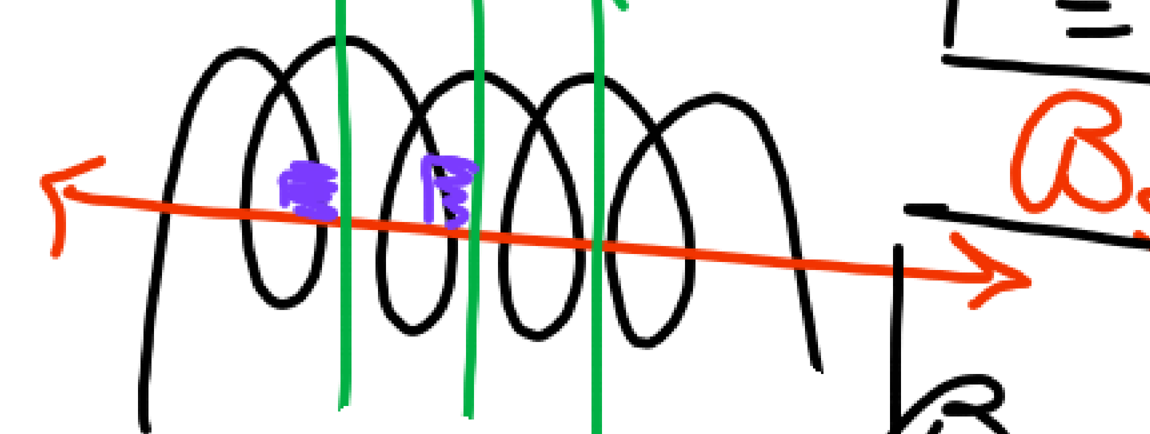
2 Solenoid + B_{ext}



$$\boxed{B_T = B_S + B_{ext}}$$



$$\boxed{B_T = B_S - B_{ext} \text{ or } B_{ext} - B_S}$$



$$B_T = \sqrt{B_S^2 + B_{ext}^2}$$