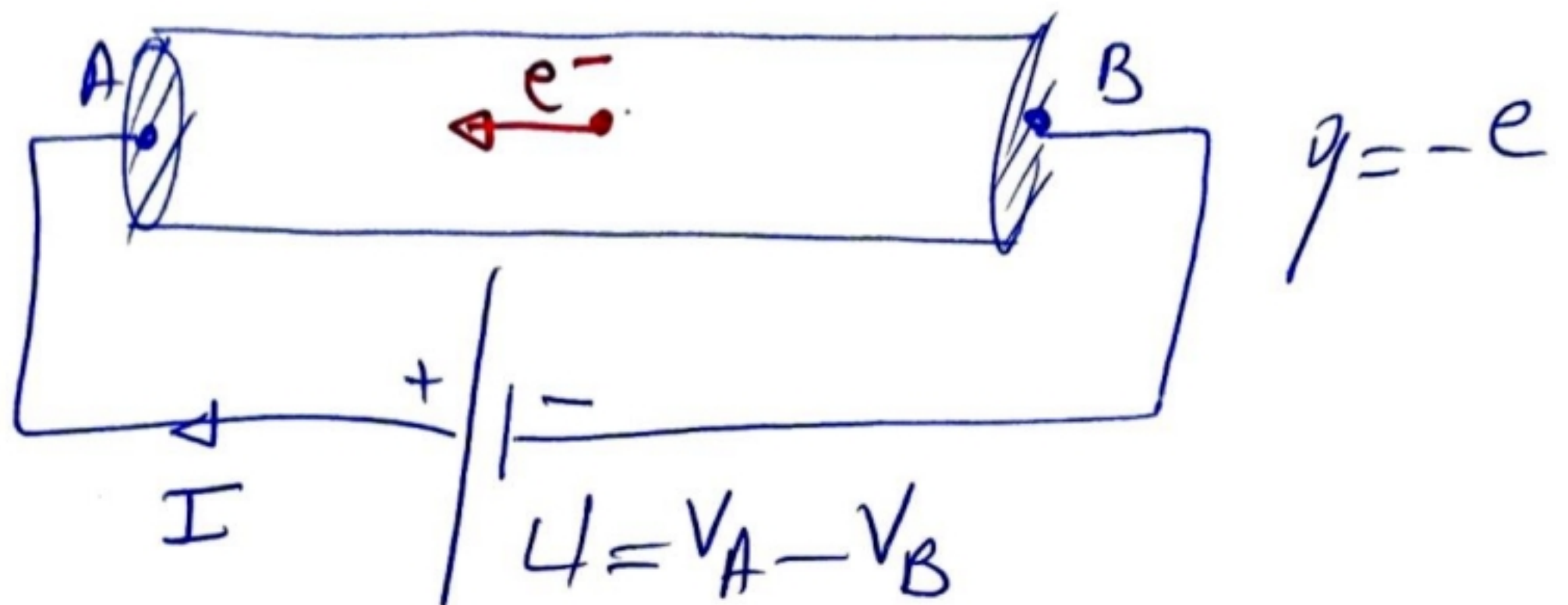


Model de Drinde



R.F.D.: $m \frac{d\vec{v}}{dt} = -e\vec{E} + m\vec{g} - \frac{m}{\tau}\vec{v}$

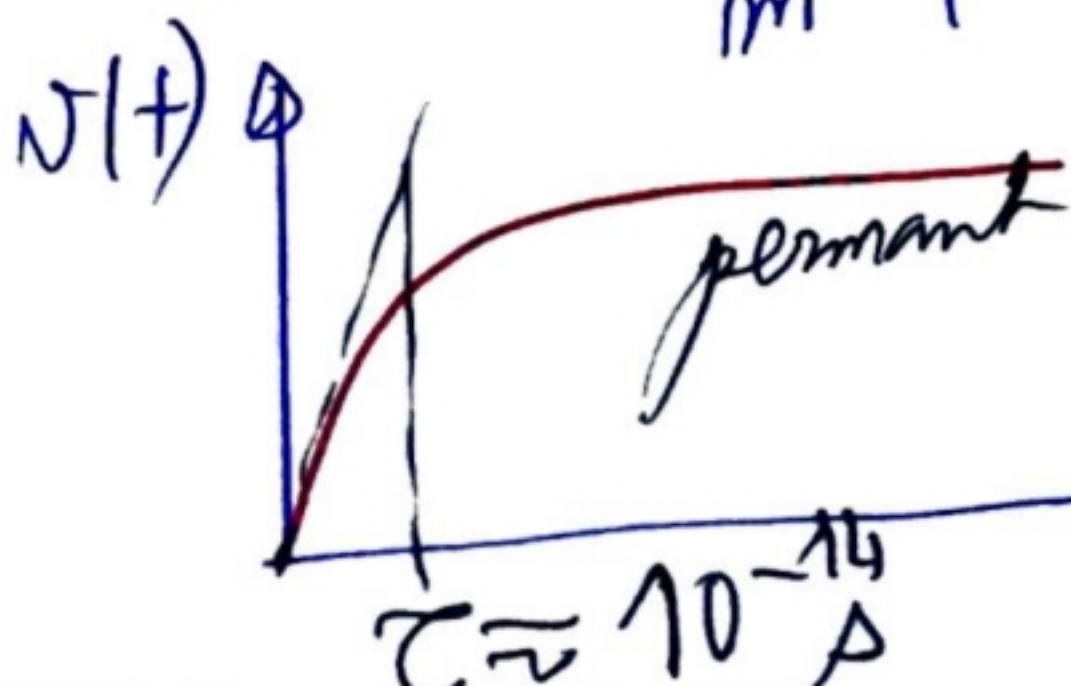
$\approx \frac{\|\vec{I}\|}{\|\vec{F}_e\|} \ll 1$

$$\frac{d\vec{v}}{dt} + \frac{\vec{v}}{\tau} = -\frac{e}{m}\vec{E}$$

$$\vec{v}(t) = A \exp\left(-\frac{t}{\tau}\right) - \frac{e\tau}{m}\vec{E}$$

$$\vec{v}(t \rightarrow \infty) = \vec{0} \Rightarrow A = \frac{e\tau}{m}\vec{E}$$

$$\vec{v}(t) = -\frac{e\tau}{m} \left(1 - \exp\left(-\frac{t}{\tau}\right)\right) \vec{E}$$



$$\vec{v} \approx -\left(\frac{e\tau}{m}\right)\vec{E} = \vec{v}_d$$

$$\vec{J}_d = -ne\vec{v}_d = -ne\left(-\frac{e\tau}{m}\right)\vec{E} = \frac{ne^2\tau}{m}\vec{E}$$

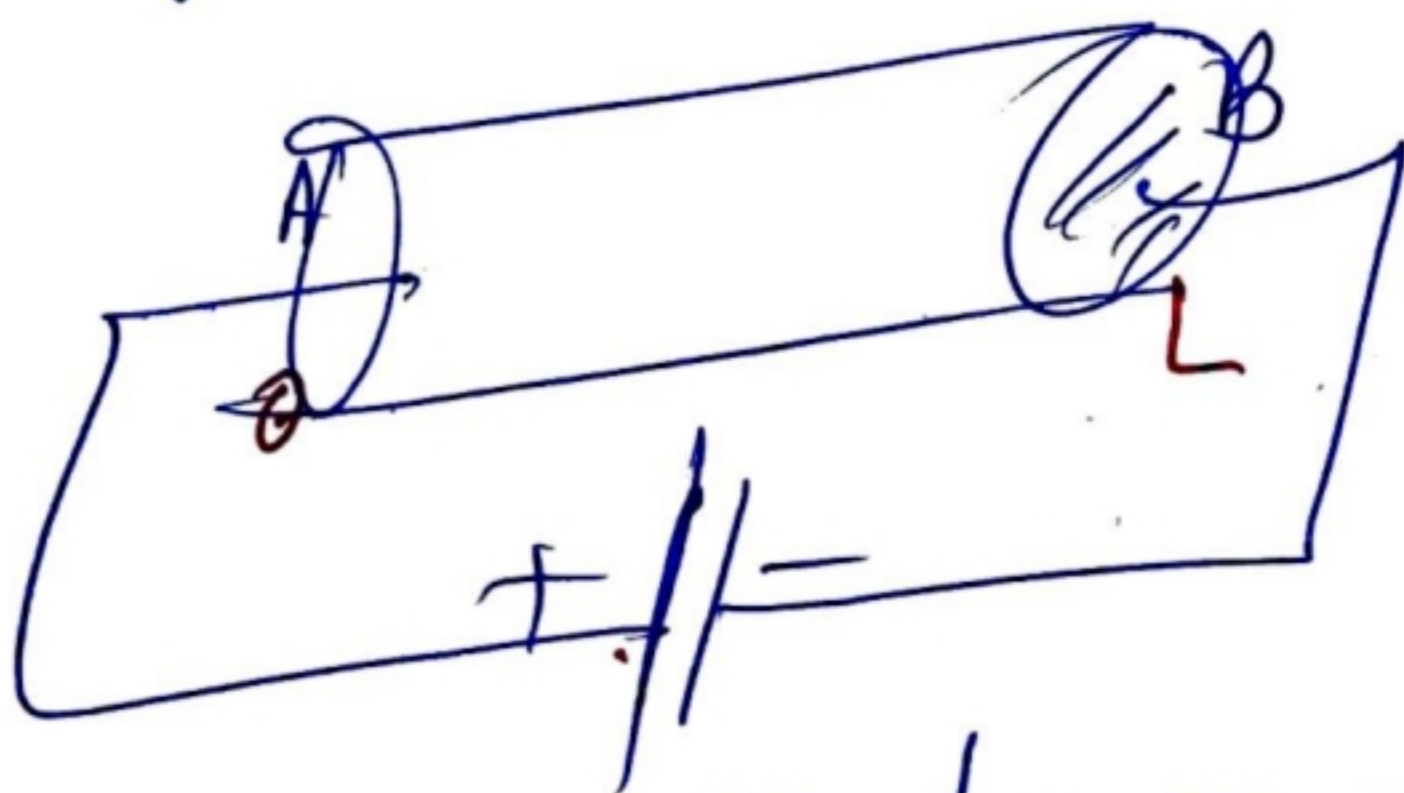
✓ $\mu = \frac{e\tau}{m} \Rightarrow$ La mobilité

$$\vec{j} = nq\vec{v} = -ne\vec{v} = +\left(\frac{ne^2\tau}{m}\right)\vec{E}$$

$$\vec{j} = \sigma \vec{E}$$

$$\sigma = \frac{ne^2\tau}{m} = \text{La conductivité}$$

$$\vec{E} = -\vec{\nabla}V = -\frac{dV}{dx}\vec{e}_x$$



$$dV = -E dx = -\frac{j}{\sigma} dx$$

$$\int_{V_+}^{V_-} dV = -\frac{1}{\sigma} \left(\frac{I}{S}\right) \int_0^L dx$$

$$V_+ - V_- = U = \left(\frac{1}{\sigma} \frac{L}{S}\right) I = RI$$

Drübel

$\vec{j} = \sigma \vec{E}$: Loi d'Ohm, locale

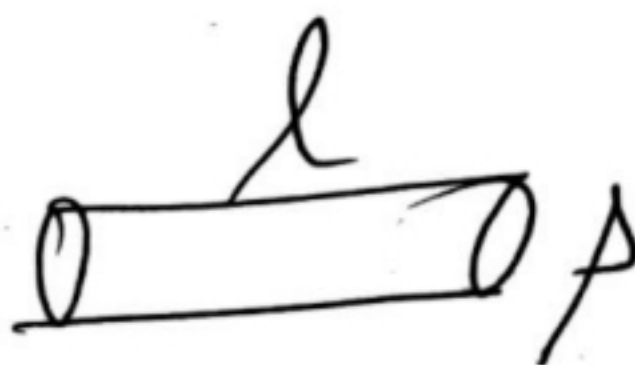
$U = RI$: / / /

$$\sigma = \frac{ne^2\tau}{m}$$

$$n = \frac{\rho_{\text{masse}} N_A}{M}$$

$$R = \frac{1}{\sigma} \frac{l}{S}$$

$\frac{1}{\sigma}$ = résistivité



$$R = \frac{U}{I}$$

$$P_{\text{Joule}} = RI^2 = \iiint p_{\text{Joule}} \cdot d\tau$$

$p_{\text{Joule}} \text{ watt/m}^3$

$$p_{\text{Joule}} = \vec{j} \cdot \vec{E} = \sigma E^2 = \frac{j^2}{\sigma}$$

$$\frac{dP_{\text{Joule}}}{d\tau} = \frac{\vec{F}_e \cdot \vec{v}}{d\tau} = \frac{dq \vec{E} \cdot \vec{v}}{d\tau}$$

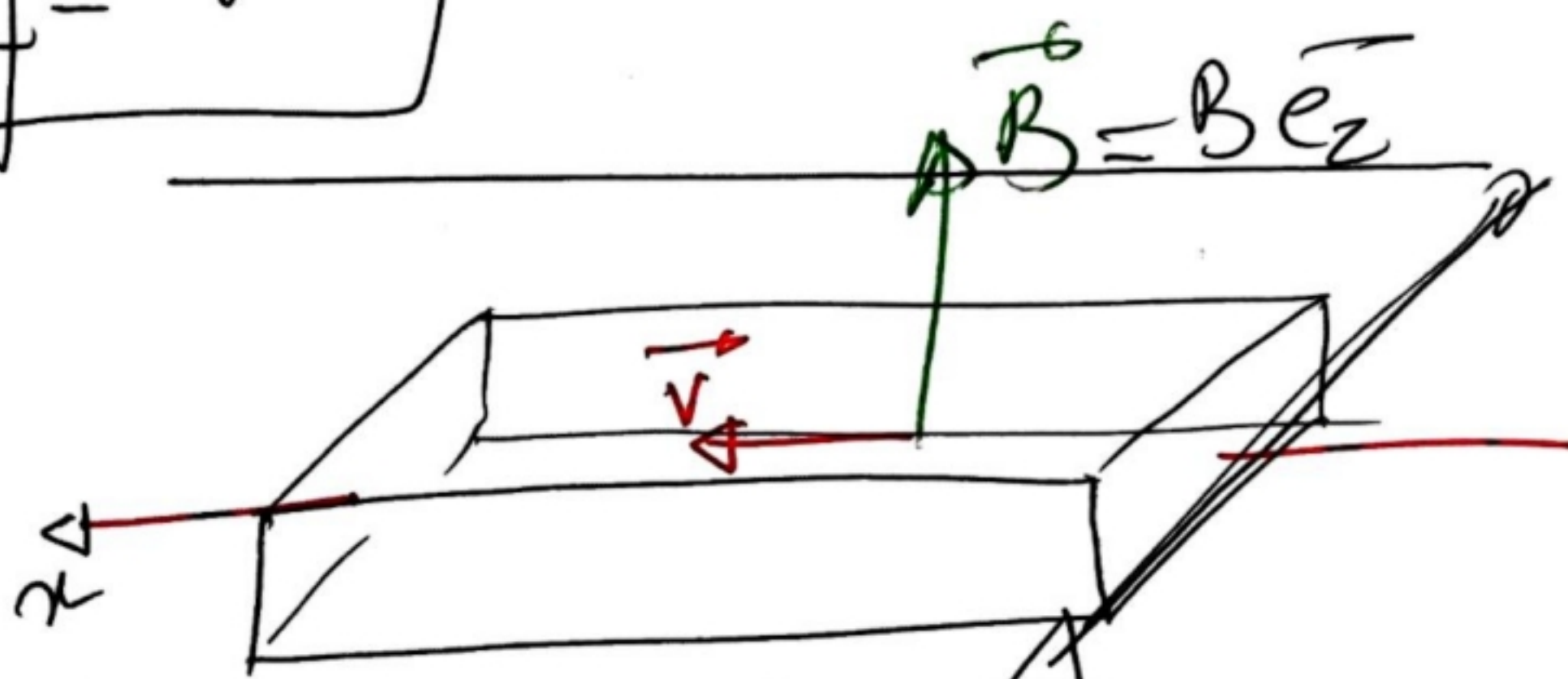
$$= \oint \vec{v} \cdot \vec{E} = \vec{j} \cdot \vec{E}$$

$$P_{\text{rule}} = \iiint (\vec{j} \cdot \vec{E}) d\tau = \frac{j^2}{\gamma} S L$$

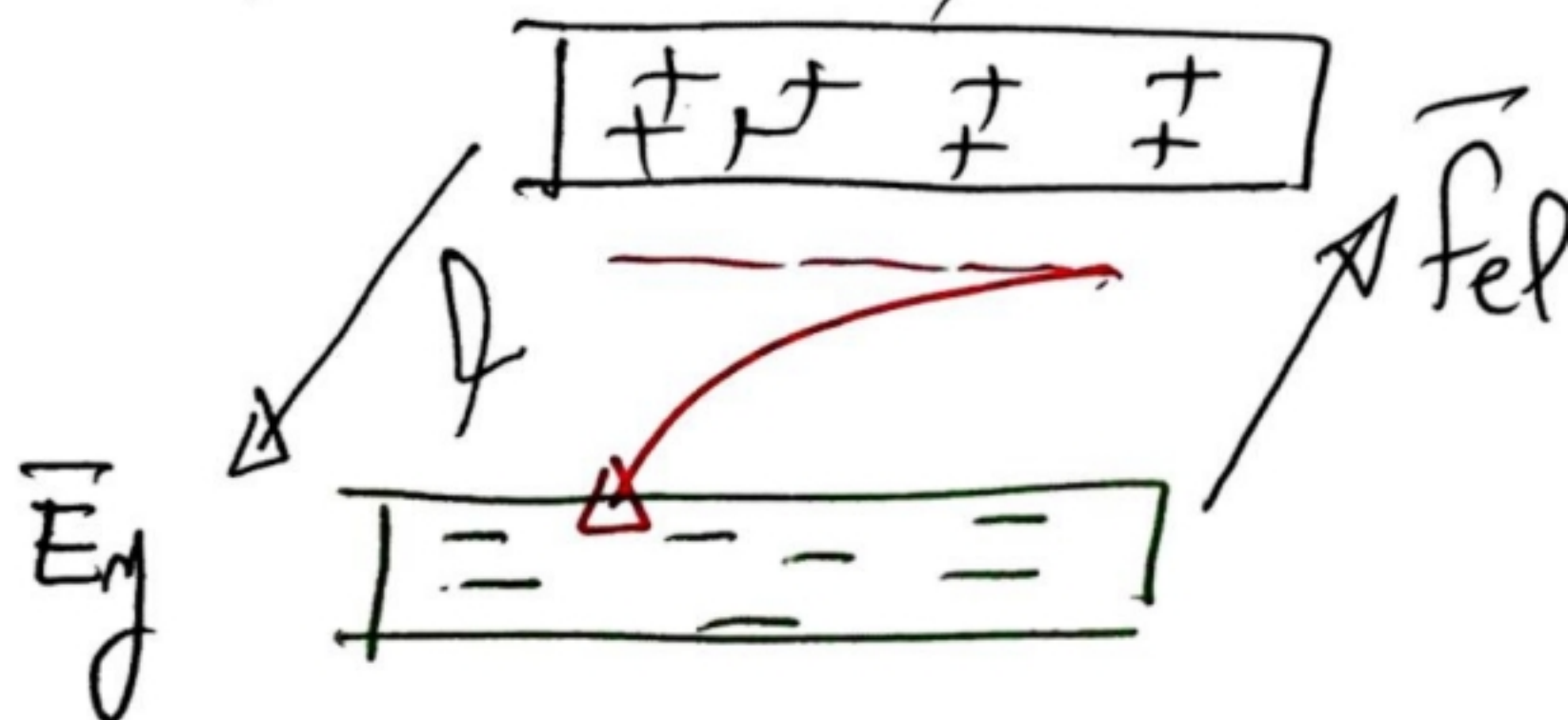
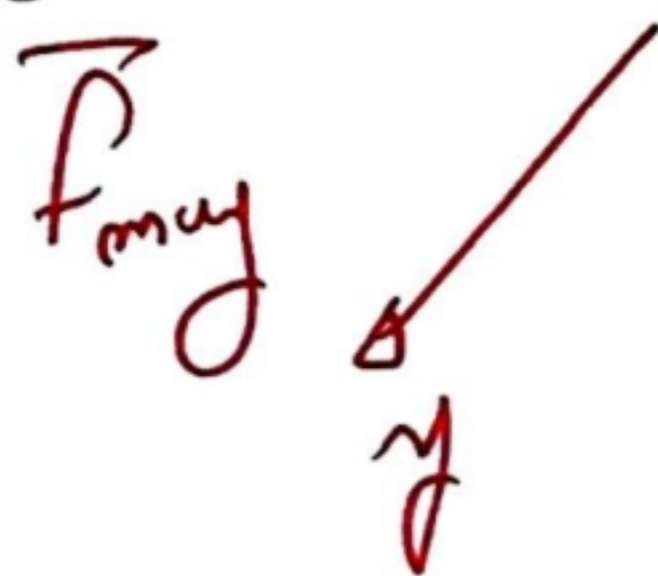
$$\text{or } I = j S \Rightarrow j = \frac{I}{S}$$

$$P_{\text{rule}} = \left(\frac{1}{\gamma} \frac{L}{S} \right) I^2$$

$$\vec{j} = \gamma \vec{E}$$



$$\vec{F}_{\text{mag}} = q(\vec{v} \wedge \vec{B}) = -e(\vec{v} \wedge \vec{B})$$



$$\boxed{\vec{F}_{mag} + \vec{F}_{ed} = \vec{0}} \quad (oy)$$

$$e \|\vec{v}\| \|\vec{B}\| = e \|\vec{E}\|$$

$$\|\vec{v}\| \|\vec{B}\| = \|\vec{E}\|$$

$$\frac{\|\vec{F}\|}{ne} \|\vec{B}\| = \frac{U}{l} \quad \left| \begin{array}{l} \vec{E} = -\frac{dV}{dy} \\ \int dV = -E \int dy \\ U = El \end{array} \right.$$

$$\vec{J} = nq\vec{v} = -ne\vec{v}$$

$$\boxed{\frac{I}{Sne} \|\vec{B}\| = \frac{U}{l}}$$

Exercice

$$\vec{E} = \begin{pmatrix} E_x \\ E_y \\ E_z \end{pmatrix}$$

$$\vec{B} = \begin{pmatrix} 0 \\ 0 \\ B \end{pmatrix}$$

$$\vec{F}_{vis} = -\lambda \vec{v} = -\frac{m}{2} \vec{v}$$

en régime permanent

$$\frac{d\vec{v}}{dt} = \vec{0} \Rightarrow \Sigma \vec{F}_{ext} = \vec{0}$$

$$+e\vec{E} + e(\vec{v} \wedge \vec{B}) + \frac{m}{\tau} \vec{v} = \vec{0}$$

$$e\vec{E} + e\left(\frac{-\vec{j}}{ne} \wedge \vec{B}\right) + \frac{m}{\tau}\left(\frac{-\vec{j}}{ne}\right) = \vec{0}$$

$$\frac{m}{\tau ne} \vec{j} = e \left[\vec{E} - \frac{\vec{j} \wedge \vec{B}}{ne} \right]$$

$$\vec{j} = \frac{ne^2 \tau}{m} \left(\vec{E} - \frac{\vec{j} \wedge \vec{B}}{ne} \right)$$

$$\vec{j} = \gamma \left(\vec{E} - \frac{\vec{j} \wedge \vec{B}}{ne} \right)$$

$$\textcircled{A} \quad \vec{j} \wedge \vec{B} = \begin{vmatrix} \hat{j}_x \\ \hat{j}_y \\ \hat{j}_z \end{vmatrix} \wedge \begin{vmatrix} 0 \\ 0 \\ B \end{vmatrix} = \begin{vmatrix} B \hat{j}_y \\ -B \hat{j}_x \\ 0 \end{vmatrix}$$

$$j_x = \gamma \left(E_x - \frac{B}{ne} j_y \right)$$

$$j_z = \gamma E_z$$

$$j_y = \gamma \left(E_y + \frac{B}{ne} j_x \right)$$

$$\hat{j}_x + \frac{\gamma B}{ne} \hat{j}_y = \gamma E_x \quad (1)$$

$$\hat{j}_y - \frac{\gamma B}{ne} \hat{j}_x = \gamma E_y \quad (2)$$

$$(1) + (2) \left(-\frac{\gamma B}{ne} \right)$$

$$\hat{j}_x \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right) = \gamma \left(E_x - \frac{\gamma B}{ne} E_y \right)$$

$$(1) \left(\frac{\gamma B}{ne} \right) + (2)$$

$$\hat{j}_y \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right) = \gamma \left(E_y + \frac{\gamma B}{ne} E_x \right)$$

$$\hat{j}_z = \gamma E_z$$

$$\begin{pmatrix} \hat{j}_x \\ \hat{j}_y \\ \hat{j}_z \end{pmatrix} = \gamma \begin{pmatrix} 1 & -\gamma B/ne & 0 \\ \frac{\gamma B/ne}{1 + \frac{\gamma^2 B^2}{n^2 e^2}} & \frac{1}{1 + \frac{\gamma^2 B^2}{n^2 e^2}} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} E_x \\ E_y \\ E_z \end{pmatrix}$$

$$[\vec{J}] = [\gamma][\vec{E}]$$

matrice : matériau isotrope

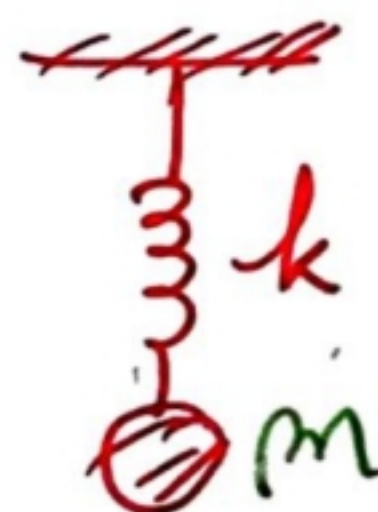
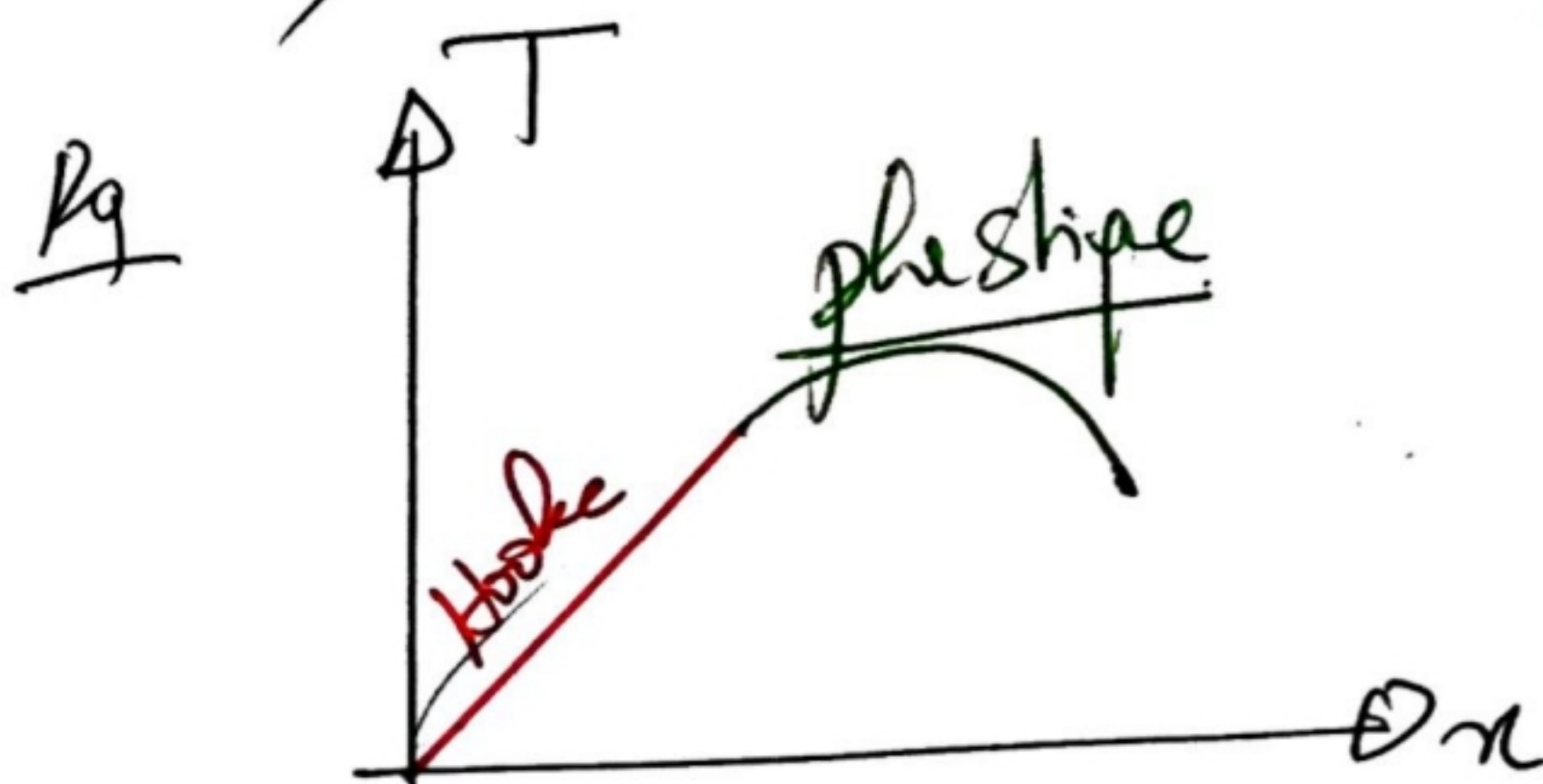
$$I_{\text{sphère}} = \frac{2}{5} m R^2 \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$



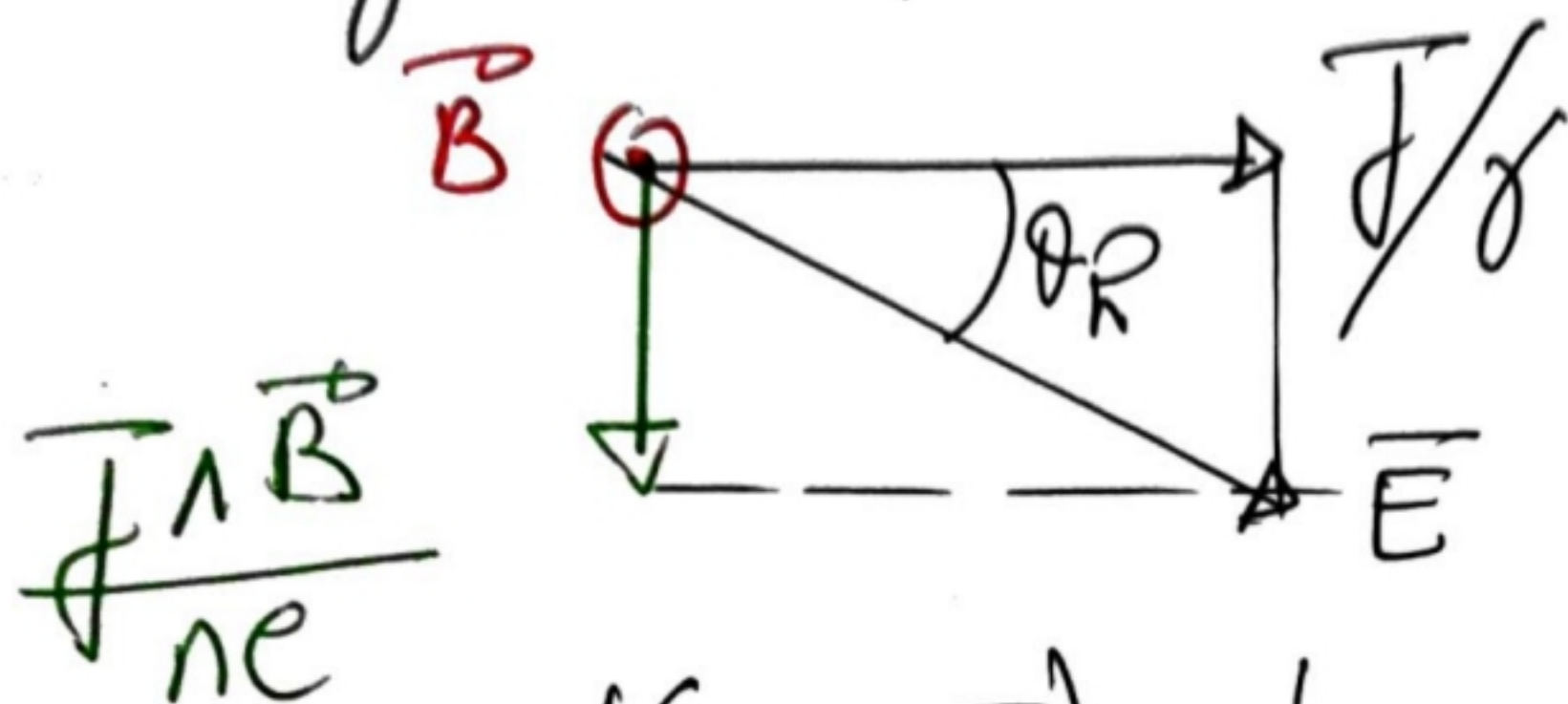
$$\frac{m l^2}{12}$$

disque $\frac{m R^2}{2}$

$\delta(B^2)$: fonction non linéaire



$$b) \quad \frac{\vec{J}}{\gamma} + \frac{\vec{J} \wedge \vec{B}}{ne} = -\vec{E}$$



$$\tan \theta_R = \left| \frac{(\vec{J} \wedge \vec{B}) / ne}{\vec{J} / \gamma} \right| = \frac{\|\vec{B}\| \gamma}{ne}$$

$\theta_R \nearrow$; $\sin n \searrow$

$$n_{\text{airu}} = 10^{23} \text{ e}^-/\text{m}^3$$

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$n \searrow \Rightarrow$ un matériau semi-conducteur
Si, Ge

$$2) \quad \vec{J} = j_x \vec{e}_x; \quad j_y = j_z = 0 \quad \begin{matrix} \searrow \\ E_z = 0 \end{matrix}$$

$$(1) \Rightarrow j_x = \gamma E_x$$

$$(2) \Rightarrow \boxed{E_y = -\frac{B}{ne} j_x}$$

semi-conducteur
 $n \searrow$
 $\|\vec{E}_y\| \nearrow$

$$3) \vec{E}_n, \quad E_y = E_z = 0$$

$$R_0 = \frac{1}{\gamma} \frac{l}{S}$$

$$* E_n = -\frac{dV}{dn} \Rightarrow dV = -E_n dn$$

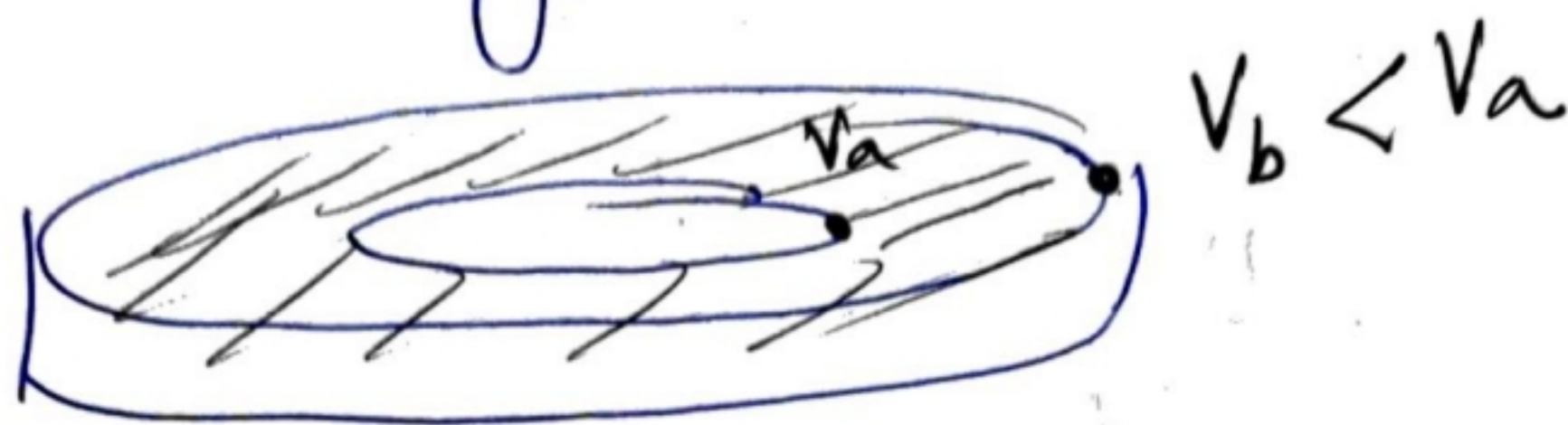
$$\int_{V^+}^{V^-} dV = - \frac{j_n}{\gamma} \int_0^l dn \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right)$$

$$2 \int_0^l j_n \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right) = \gamma (E_n - 0)$$

$$U = V^+ - V^- = \frac{l}{\gamma S} \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right) I$$

$$R_B = R_0 \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right)$$

Magnétorésistance



Disque de Corbino

$$1) \quad \begin{aligned} j_z + \frac{\gamma B}{ne} j_\theta &= \gamma E_r \\ j_\theta - \frac{\gamma B}{ne} j_r &= \gamma E_\theta \end{aligned} \quad \begin{aligned} j_\theta &= \gamma E_r \\ j_r &= \gamma E_\theta \end{aligned} \quad j_z = \gamma E_z$$

$$2) \quad \vec{E}_r = E_r \vec{e}_r; \quad E_\theta = 0, \quad E_z = 0$$

$$\boxed{j_\theta = \frac{\gamma B}{ne} j_r}$$

les lignes de courants de Bardeen

11 Bardeen $\Rightarrow$

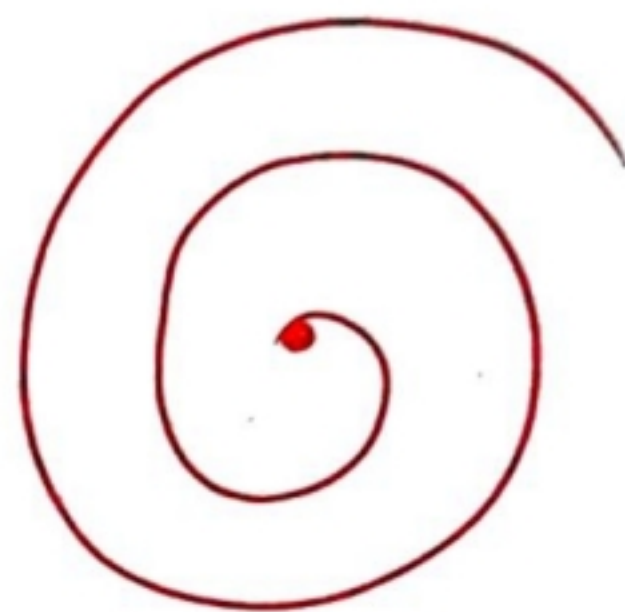
$$\frac{dr}{j_r} = \frac{r dr}{j_\theta}$$

$$\frac{dx}{j_x} = \frac{dy}{j_y}$$

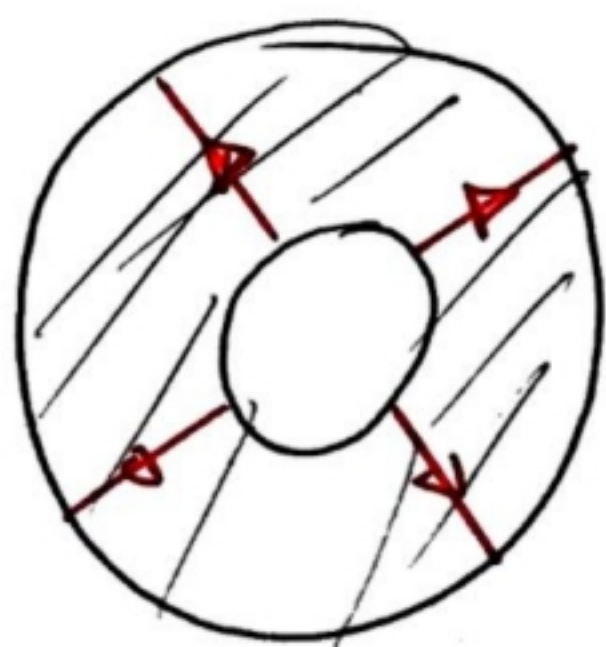
$$\frac{dr}{r} = \left(\frac{j_r}{j_\theta} \right) d\theta = \frac{ne}{\gamma B} d\theta$$

$$\ln r = \frac{ne\theta}{\gamma B} + \text{cts}$$

$$r = r_0 \exp\left(\frac{ne\theta}{\gamma B}\right)$$

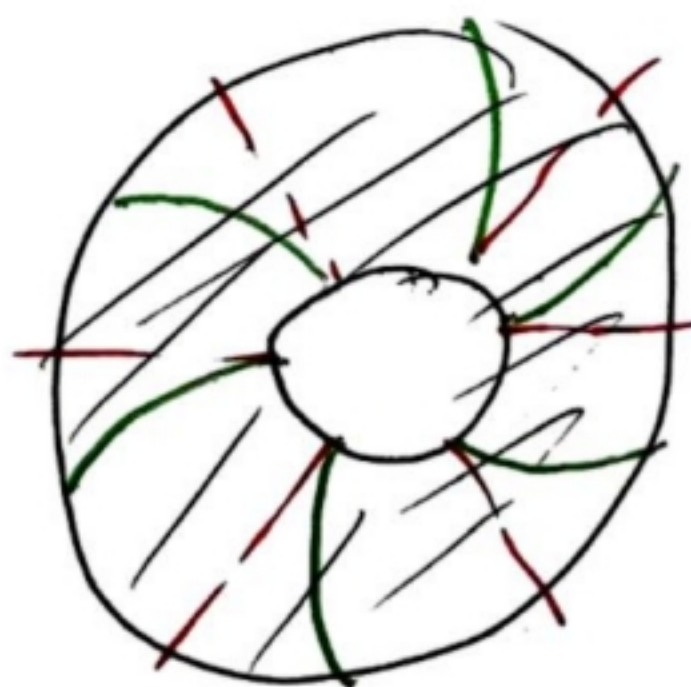


spirale logarithmique



$$\vec{B} = \vec{0}$$

$$\vec{j} = \gamma \vec{E}$$



$$\vec{B} \neq \vec{0}$$

$$[\vec{j}] = [\gamma][\vec{E}]$$

$$3) \quad j_r \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right) = \gamma E_r$$

$$\vec{E} = -\text{grad } V \Rightarrow E_r = -\frac{dV}{dr}$$

$$dV = -E_r dr$$

$$\int dV = -\frac{1}{\gamma} \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right) \int r dr$$

$$\text{or } I = \iint \vec{j} \cdot d\vec{S}_{\text{het}} = j_r \cdot 2\pi r h$$

$$j_r = \frac{I}{2\pi h r}$$

$$L = \left[\frac{1}{\gamma} \frac{1}{2\pi} \ln\left(\frac{b}{a}\right) \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right) \right] I$$

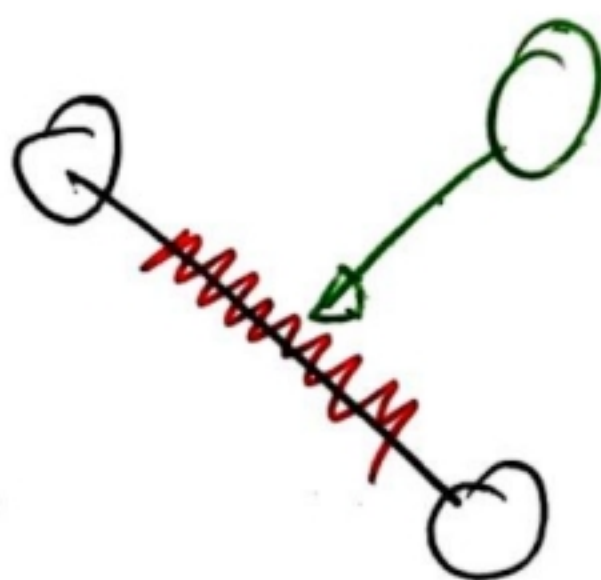
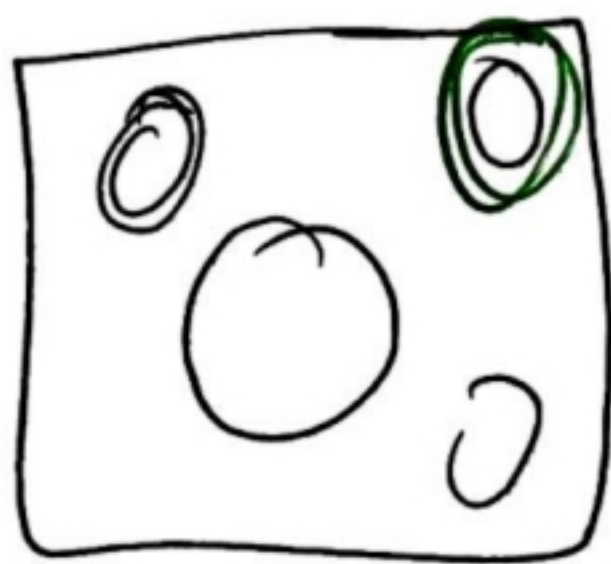
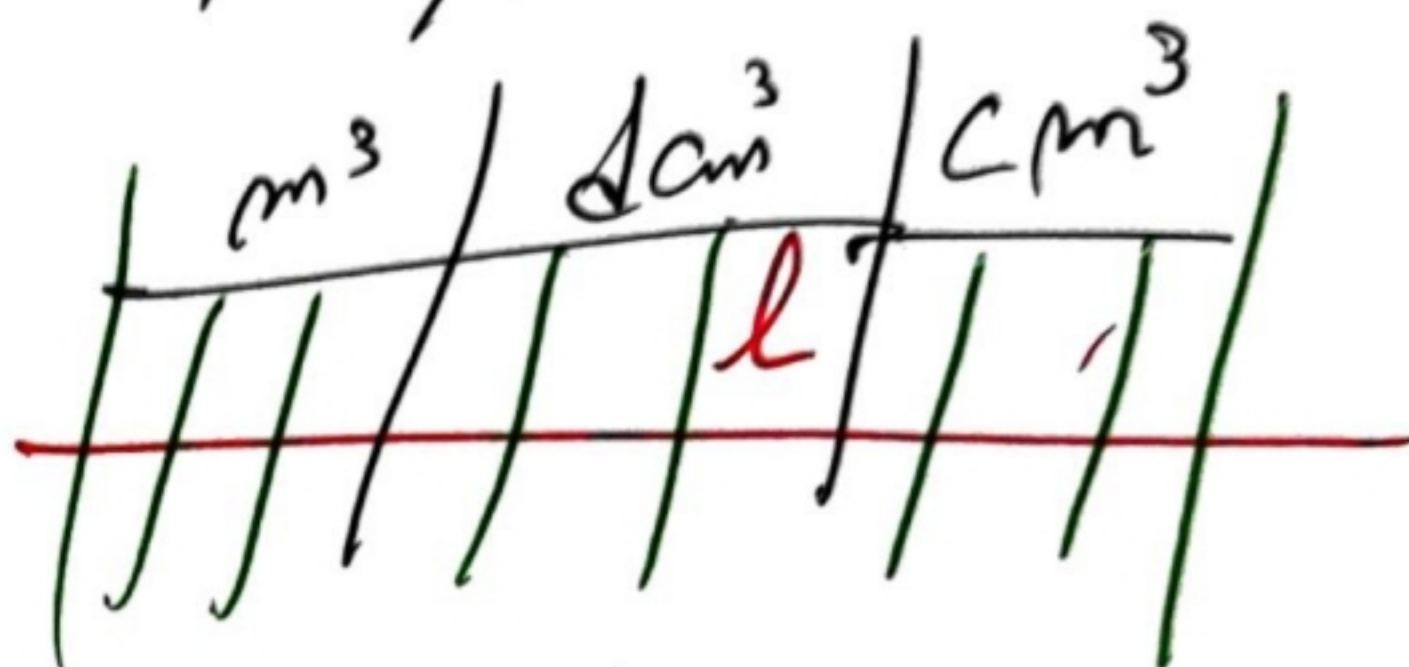
P_0
 $L = 1\text{m}$, par mètre de longueur

$$R_B = P_0 \left(1 + \frac{\gamma^2 B^2}{n^2 e^2} \right)$$

$$\Delta R = \text{incertitude (mètre)}, \quad \frac{\Delta R}{P_0} = \%$$

$$\frac{R_B - R_0}{R_0} = \frac{\delta^2 B^2}{n^2 e^2} = 0,13\%$$

$$n \approx 10^{23} \text{ e}^-/\text{m}^3$$



$$R = 10 \Omega \longrightarrow 10^6 \Omega$$

$$\frac{\Delta R}{R} = 2\%$$