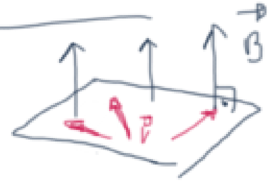
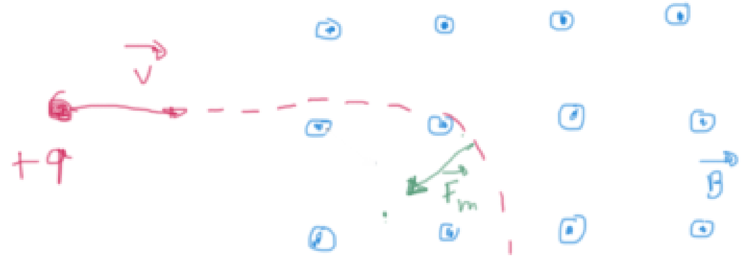
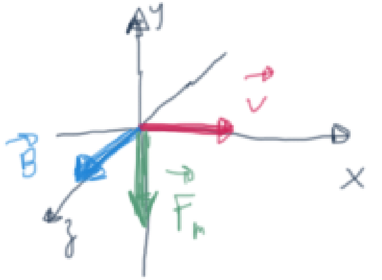
Movimento de partículas carregadas em uma região de campo magnético

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







$$\vec{F}_m = q\vec{v} \wedge \vec{B}$$

$$\downarrow$$

$$\vec{F}_m \perp \vec{v}$$

Portanto, $\vec{F}_m$ não muda → MCU!

$|\vec{v}|$, mas sim a direção e sentido de $\vec{v}$! Além disso:

$$F_m = F_{cp}$$

$$qvB\,\text{sen}\,90° = m\frac{v^2}{R} \quad (a_{cp})$$

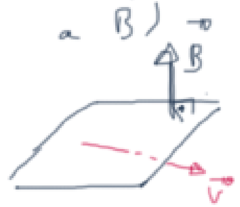
$$\therefore \boxed{R = \frac{mv}{qB}}$$

$$\therefore T = \frac{2\pi R}{v} \to \boxed{T = \frac{2\pi m}{qB}}$$

$$\therefore f = \frac{1}{T} \to \boxed{f = \frac{qB}{2\pi m}}$$

$$\therefore \omega = 2\pi f \to \boxed{\omega = \frac{qB}{m}}$$

2) $\vec{v} = \vec{v}_\perp + \vec{v}_{//}$ (em relação a $\vec{B}$)

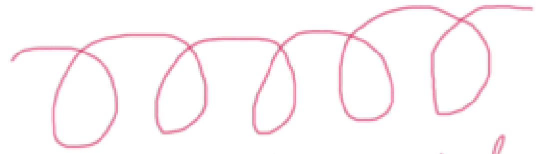


$$\vec{F}_m = q\vec{v} \wedge \vec{B}$$

$$= q(\vec{v}_\perp + \vec{v}_{//}) \wedge \vec{B}$$

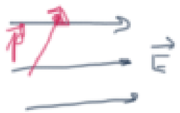
$$= \underbrace{q\vec{v}_\perp \wedge \vec{B}}_{\substack{\text{Acabamos de analisar} \\ \downarrow \\ \text{MCU}}} + \underbrace{q\vec{v}_{//} \wedge \vec{B}}_{\substack{0 \\ \downarrow \\ \vec{v}_{//} = \text{constante}}}$$

∴



(movimento em espiral da partícula)

$\hat{i}\wedge\hat{j}=\hat{k}$ / $\hat{j}\wedge\hat{i}=-\hat{k}$



$U_E = -\vec{p}\cdot\vec{E}$

Movimento de cargas na região de $\vec{B}$ e $\vec{E}$

Força de Lorentz: $\vec{F}_L = \vec{F}_E + \vec{F}_m$

$= q\vec{E} + q\vec{v}\wedge\vec{B}$

$= q(\vec{E}+\vec{v}\wedge\vec{B})$

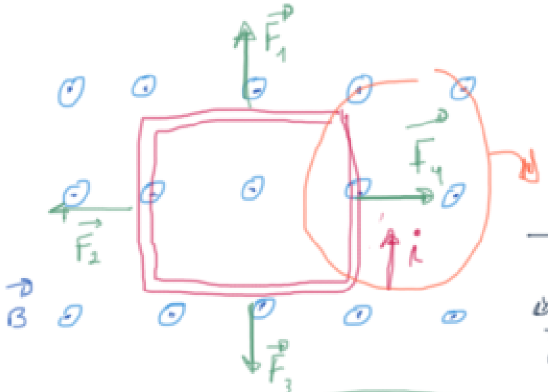
Aplicações: 1) Filtro de velocidades

2) Espectrômetro de massa

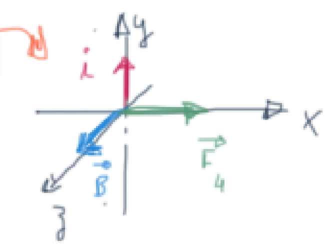
3) Efeito Hall

(Veremos isso na forma de exercícios)

Força em uma espira numa região de $\vec{B}$ (uniforme)



$\vec{F} = i\vec{L}\wedge\vec{B}$



$$\boxed{\vec{F}_R = \vec{F}_1+\vec{F}_2+\vec{F}_3+\vec{F}_4=\vec{0}}$$

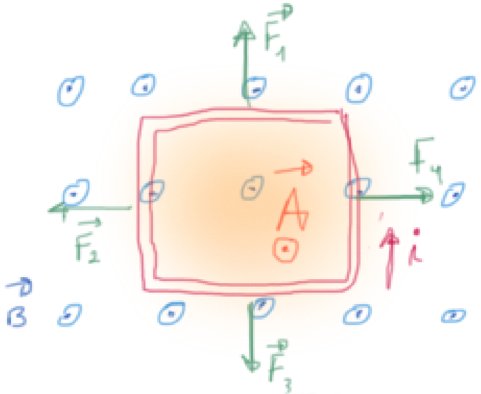
Isso vale para qualquer formato!

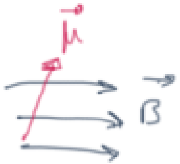
$d\vec{F} = i\,d\vec{l}\wedge\vec{B}$

$\vec{F}_R = \oint i\,d\vec{l}\wedge\vec{B} = -i\oint\vec{B}\wedge d\vec{l}$

$= -i\vec{B}\wedge\underbrace{\oint d\vec{l}}_{\vec{0}} = 0$

Torque em um espira numa região de $\vec{B}$





$\vec{A} = A\hat{n}$

$$\boxed{\vec{\tau} = i\vec{A}\wedge\vec{B}}$$

ou

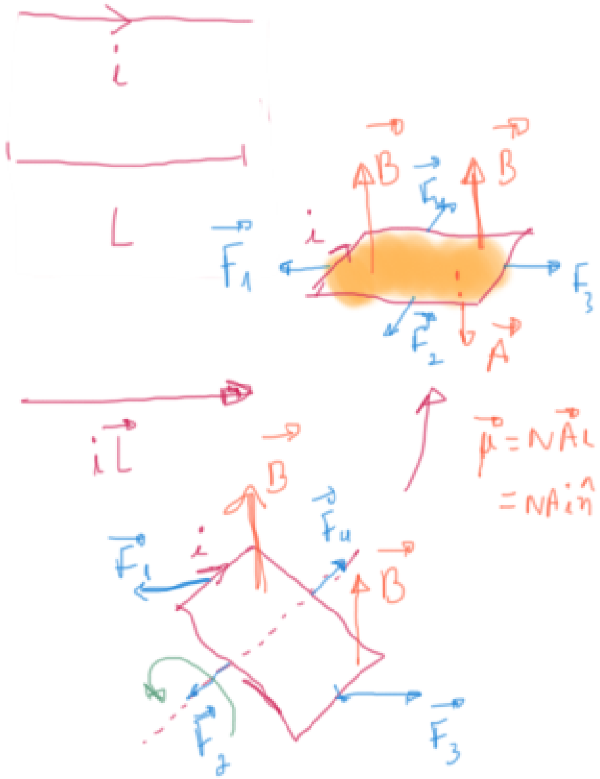
$$\boxed{\vec{\tau} = \vec{\mu}\wedge\vec{B}}$$

com $\boxed{\vec{\mu} = N i A\hat{n}}$ (momento de dipolo magnético)

N = qtde de espiras

$$\Rightarrow \boxed{U_B = -\vec{\mu}\cdot\vec{B}}$$

Respostas às perguntas

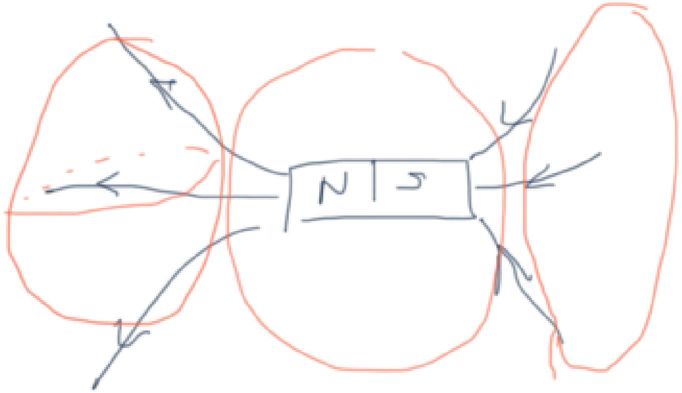


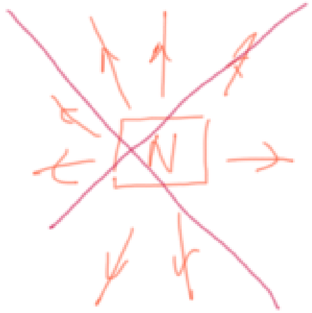
$\Phi_E = \int \vec{E} \cdot d\vec{A} \rightarrow$ def. fluxo elétrico

$$\boxed{\Phi_{E_T} = \oint \vec{E} \cdot d\vec{A} = \frac{q_{int}}{\varepsilon_0}}$$ gauss

$\Phi_M = \int \vec{B} \cdot d\vec{A} \rightarrow$ def fluxo magnético

$\Phi_{M_T} = \oint \vec{B} \cdot d\vec{A} = 0$

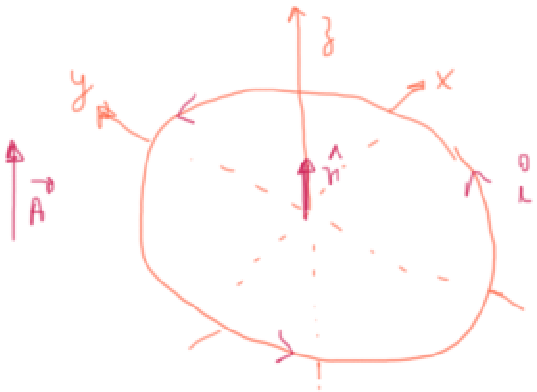




i no sentido HORÁRIO

$\vec{A} = A\hat{n}$

$\downarrow \vec{A}$



i no sentido ANTI HORÁRIO

EX. 27.1, p.232

$q = -1{,}24 \cdot 10^{-8}\ C$

$\vec{v} = (4{,}19\,\hat{i} - 3{,}85\,\hat{j})\,10^{4}\ \frac{m}{s}$

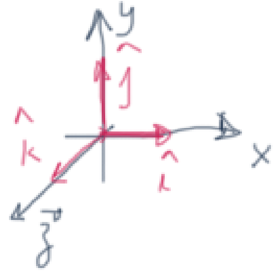
a) $\vec{B} = 1{,}40\,\hat{i}\ (T)$

$$\boxed{\vec{F}_m = q\,\vec{v} \wedge \vec{B}}$$

$$= -1{,}24 \cdot 10^{-8} \cdot 10^{4}(4{,}19\,\hat{i} - 3{,}85\,\hat{j}) \wedge 1{,}40\,\hat{i}$$

$$= -1{,}24 \cdot 10^{-4}\big(\underbrace{4{,}19\,\hat{i} \wedge 1{,}40\,\hat{i}}_{0} \underbrace{-3{,}85\,\hat{j} \wedge 1{,}40\,\hat{i}}_{-3{,}85 \cdot 1{,}40 \cdot (-\hat{k})}\big)$$

$$= -6{,}68 \cdot 10^{-4}\,\hat{k}\ (N)$$



$\hat{i} \wedge \hat{j} = \hat{k}$, $\hat{j} \wedge \hat{i} = -\hat{k}$

$\hat{j} \wedge \hat{k} = \hat{i}$

$\hat{k} \wedge \hat{i} = \hat{j}$, $\hat{i} \wedge \hat{k} = -\hat{j}$

b) $\vec{B} = 1{,}40\,\hat{k}\ (T)$

$$\vec{F}_m = -1{,}24 \cdot 10^{-4}\big(\underbrace{4{,}19\,\hat{i} \wedge 1{,}40\,\hat{k}}_{4{,}19 \cdot 1{,}40 \cdot (-\hat{j})} \underbrace{-3{,}85\,\hat{j} \wedge 1{,}40\,\hat{k}}_{-3{,}85 \cdot 1{,}40\,\hat{i}}\big)$$

$$\boxed{\vec{F}_m = (6{,}68\,\hat{i} + 7{,}27\,\hat{j}) \cdot 10^{-4}\ N}$$

27.4, p.223

$m = 1{,}81 \cdot 10^{-3}\ kg$

$q = 1{,}22 \cdot 10^{-8}\ C$

$\vec{v} = 3{,}0 \cdot 10^{4}\,\hat{j}\ \left(\frac{m}{s}\right)$

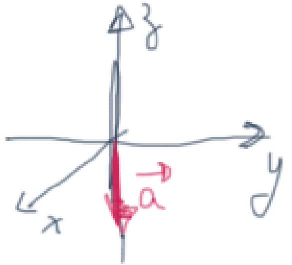
$\vec{a} = ?$

$\vec{B} = 1{,}63\,\hat{i} + 0{,}980\,\hat{j}\ (T)$

$$\vec{F}_m = q\,\vec{v} \wedge \vec{B} \rightarrow \vec{a} = \frac{\vec{F}_m}{m} = \frac{q}{m}\,\vec{v} \wedge \vec{B}$$

$$\vec{a} = \frac{1{,}22 \cdot 10^{-8}}{1{,}81 \cdot 10^{-3}} \cdot 3{,}0 \cdot 10^{4}\,\hat{j} \wedge (1{,}63\,\hat{i} + 0{,}980\,\hat{j})$$

$$\boxed{\vec{a} = -0{,}33\,\hat{k}}\ \left(\frac{m}{s^2}\right)$$



MÓDULO: $0{,}33\ \frac{m}{s^2}$

DIREÇÃO: z, vertical

sentido: $-z$, de cima para baixo