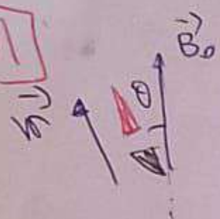
7 - Campo Magnético (Moysés Nussenzveig) Volume 3

F ~~co~~ Jardisson Moreira, UFC

$\boxed{01}$



$$\vec{\tau} = \vec{m} \times \vec{B}_0 = -|\vec{m}| \cdot |\vec{B}_0| \operatorname{sen}\theta$$

$$\Rightarrow \begin{cases} \tau \cong -mB_0\theta \\ \tau = I\alpha = I\ddot{\theta} \end{cases}$$

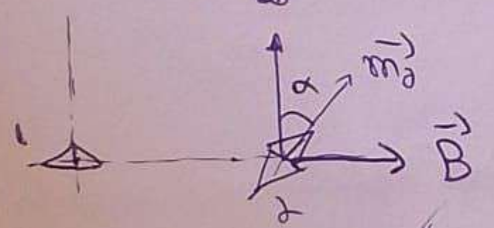
$$\Rightarrow I\ddot{\theta} = -mB_0\theta \rightarrow \ddot{\theta} = -\underbrace{\frac{mB_0}{I}}_{\omega_0^2}\theta \rightarrow \omega_0 = \sqrt{\frac{mB_0}{I}}$$

Mas: $\omega_0 = 2\pi f \Rightarrow \sqrt{\frac{mB_0}{I}} = 2\pi f$

$$\Rightarrow f = \frac{1}{2\pi}\sqrt{\frac{mB_0}{I}}$$

$\boxed{02}$ a) $\vec{E}(z) = \frac{\vec{p}}{2\pi\varepsilon_0} \cdot \frac{1}{z^3} \rightarrow \vec{B}(d) = \frac{\mu_0\vec{m}}{2\pi} \cdot \frac{1}{d^3} = \vec{B}$

b)



$$\vec{\tau}_{B_0} = \vec{m}_2 \times \vec{B}_0 \rightarrow |\tau_{B_0}| = m_2|B_0|\operatorname{sen}\alpha$$

$$\vec{\tau}_{\vec{B}} = \vec{m}_2 \times \vec{B} \rightarrow |\tau_B| = m_2|B|\cos\alpha$$

Equilíbrio: $\cancel{m_2}|B_0|\operatorname{sen}\alpha = \cancel{m_2} \cdot \frac{\mu_0|m|}{2\pi}\frac{1}{d^3}\cos\alpha$

$|\tau_{B_0}| = |\tau_B|$

$$tg\,\alpha = \frac{\mu_0\,|m|}{2\pi d^3\,|B_0|}$$

03

a) $\vec{F} = q\vec{V}\times\vec{B} = eVB = e(\omega r)B$ $\Rightarrow$ $e\cancel{\omega}rB = m\omega^{\cancel{2}}\cancel{r}$

$F_{cp} = m\omega^2 r$

$$\omega = \frac{eB}{m} = \frac{1{,}6\cdot10^{-19}\cdot5\cdot10^{-5}}{9{,}1\cdot10^{-31}}$$

$$= 8{,}79\,(\text{rad/s})\,10^{6}$$

Mas: $\omega = 2\pi f \Rightarrow f = \dfrac{8{,}79\cdot10^{6}}{2\pi} \cong 1{,}39\cdot10^{6}\,\text{Hz}$

b) $F_{cp} = \dfrac{mv^2}{r} \Rightarrow \dfrac{mv^{\cancel{2}}}{r} = e\cancel{V}B \Rightarrow r = \dfrac{mV}{eB} = \dfrac{m\sqrt{\dfrac{2E}{m}}}{eB} = \dfrac{\sqrt{2mE}}{eB}$

$$= \frac{\sqrt{2\cdot9{,}1\cdot10^{-31}\cdot1{,}6\cdot10^{-19}\cdot10^{3}}}{1{,}6\cdot10^{-19}\cdot5\cdot10^{-5}} = \frac{\sqrt{29{,}12\cdot10^{-47}}}{8\cdot10^{-24}} = \frac{\sqrt{291{,}2}\cdot10^{-24}}{8\cdot10^{-24}} = 2{,}13\,m$$

04

i) $F_E = F_B \Rightarrow eE = eVB \Rightarrow V = \dfrac{E}{B}$

ii) $\vec{F} = e\,\vec{V}\times\vec{B}' \Rightarrow F = e\left(\dfrac{E}{B}\right)B' = \dfrac{eEB'}{B}$

$F_{cp} = \dfrac{mV^2}{R} = \dfrac{mE^2}{RB^2}$

$$\frac{eEB'}{\cancel{B}} = \frac{mE^2}{RB^2}$$

$$\Rightarrow R = \frac{mE}{eBB'}$$

05

i) Torque ocasionado devido a passagem de corrente na espira:

$\vec{\tau} = \vec{m}\times\vec{B} = i\,\vec{A}\times\vec{B} \Rightarrow |\tau| = i\pi a^2\,|\vec{B}|$

ii) Esse torque dura pouco, mas gera uma quantidade de momento angular:

$\vec{\tau} = \dfrac{d\vec{L}}{dt} \Rightarrow \Delta L = \tau\cdot\Delta t \Rightarrow L = it\pi a^2\,|\vec{B}|$

iii) Mas: $L = I\omega_0 \Rightarrow \omega_0 = \dfrac{L}{I}$ (velocidade angular inicial)

iv) Conservação da energia mecânica:

Inicial: $E_m = E_c = \frac{1}{2} I\omega_0^2$

Final: $E_m = E_p = \frac{1}{2} K\theta_0^2$

$$\Rightarrow \theta_0 = \omega_0 \sqrt{\frac{I}{K}} = \frac{L}{I}\sqrt{\frac{I}{K}} = \frac{it\pi a^2|\vec{B}|}{\sqrt{IK}}$$

$$= \frac{q\pi a^2|\vec{B}|}{\sqrt{IK}}$$