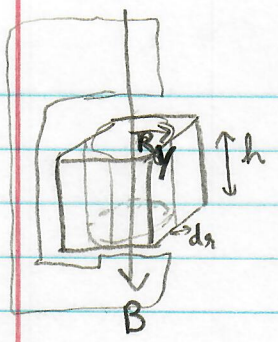
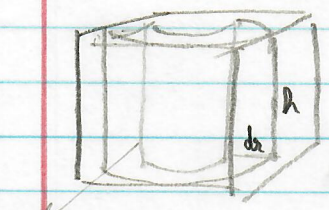
EDDY CURRENT



1) $\epsilon = -\frac{\partial \Phi}{\partial t} \overset{2)}{=} -\frac{\partial \left(B_0 \sin(\omega t)\, \pi r_e^2\right)}{\partial t}$

$= -\pi r_e^2 B_0 \omega \cos(\omega t)$ (3)

we have 4) $R = \frac{\rho L}{A}$, so



or $A = h\,dr$, $L = 2\pi r_e$,

$R = \frac{2\pi \rho r_e}{h\,dr}$. (4 or 5)

so $I = \frac{\epsilon}{R} = \frac{-\pi r_e^2 B_0 \omega \cos(\omega t)\,(h\,dr)}{2\pi \rho r_e}$

$= -\frac{r_e h B_0 \omega \cos(\omega t)\, dr}{2\rho}$ (5)

We want angular momentum, $dJ_e = dN\, m_e v_e r_e$. (#5a)

so for drift velocity v_e: (dN → number in C slice)

$v_e = \frac{dx}{dt} = \frac{dq}{dt}\frac{dx}{dq} = I\frac{dx}{dq} = \frac{I\,dx}{\rho_e\, dV}$

(ρ_e volumetric charge density $= n_e e$ (or $n q$))

$dV = AL$, $dx = L$

$= \frac{I}{\rho_e A} = \frac{I}{n_e A e}$ (#6)

Note $dN = n_e\, dV = n_e AL$. (# 6a)

so $dJ_e = n_e AL\, m_e v_e r_e = \frac{n_e A L m_e r_e I}{n_e A e}$

$= \frac{L m_e r_e I}{e} = -\frac{2\pi r_e^2 m_e I}{e}$ (# 6b)

(#5)

$$= -\frac{2\pi r_e^2 m_e I}{e} \cdot \frac{r_e h B_0 \omega \cos(\omega t)\, dr}{2\rho}$$

$$= -\frac{\pi r_e^3 h \omega B_0 m_e \cos(\omega t)\, dr}{\rho e} \qquad (\#6c).$$

So $J_{e\,(Le)} = -\frac{\pi h \omega B_0 m_e \cos(\omega t)}{\rho e} \cdot \frac{Ry^4}{4}$. (#12)

and $\rho_0 = \frac{J_e}{r_{osc}} = -\frac{\pi h \omega B_0 m_e \cos(\omega t)}{4\rho e} \cdot \frac{Ry^4}{r_{osc}}$ (#13)

$$|F|_{max} = \left|\frac{-\partial p_0}{\partial t}\right|_{max} = \boxed{\frac{\pi h \omega^2 B_0 m_e}{4\rho e} \cdot \frac{Ry^4}{r_{osc}}\ [N]} \qquad (\#14).$$

(units)

$h = 10^{-3}\,m$, $\omega = (2\pi)(13.2\times10^3\,Hz) = 8.29\times10^4\ rad/s$

$B_0 = 20\ Gauss = 2\times10^{-3}\,T$, $m_e = 9.11\times10^{-31}\,kg$

$Ry = 0.01\ in \simeq 2.54\times10^{-4}\,m$, $r_{osc} = r_0 = 0.175\ in = 4.45\times10^{-3}\,m$

$\rho = 1.6\times10^{-8}\ \Omega m$, $e = 1.602\times10^{-19}\,C$

So $|F|_{max} \simeq 862.9\, Ry^4 \simeq \boxed{3.59\times10^{-12}\,N}$