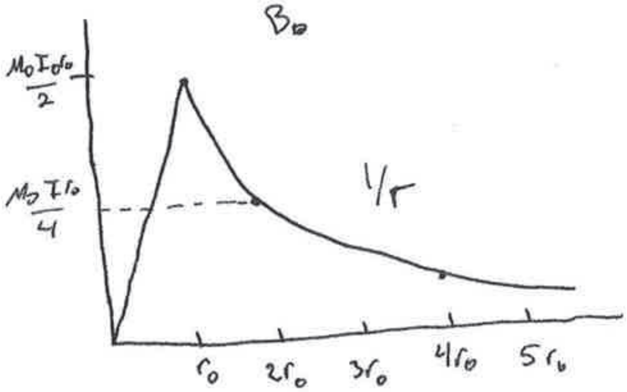
$$I_{en} = \begin{cases} I_0 & r < r_0 \\ 0 & r > r_0 \end{cases}$$

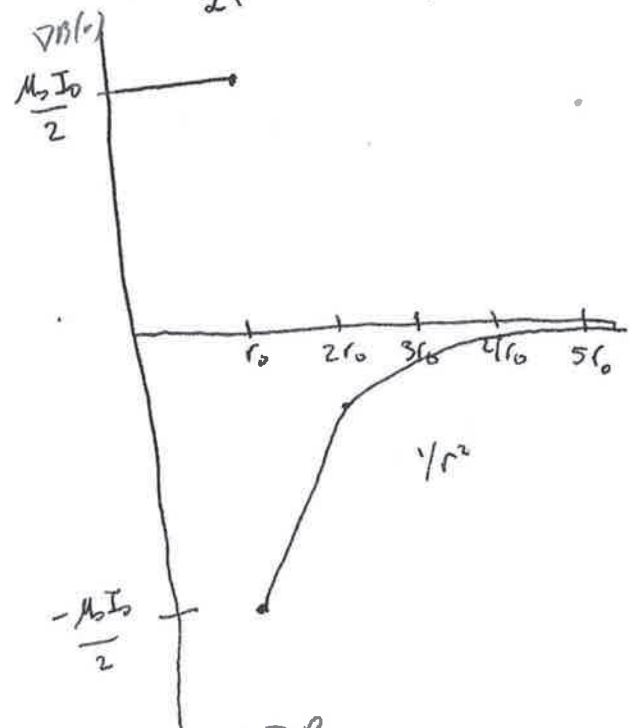
a) $$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$$

$$2\pi r B_\theta = \begin{cases} \mu_0 \pi r^2 I_0 & r < r_0 \\ \mu_0 \pi r_0^2 I_0 & r > r_0 \end{cases}$$

$$B_\theta = \begin{cases} \dfrac{\mu_0 r I_0}{2} & r < r_0 \\ \dfrac{\mu_0 r_0^2 I_0}{2r} & r > r_0 \end{cases}$$

$$\frac{\partial B_\theta}{\partial r} = \begin{cases} \dfrac{\mu_0 I_0}{2} & r < r_0 \\ \dfrac{-\mu_0 I_0 r_0^2}{2 r^2} & r > r_0 \end{cases}$$





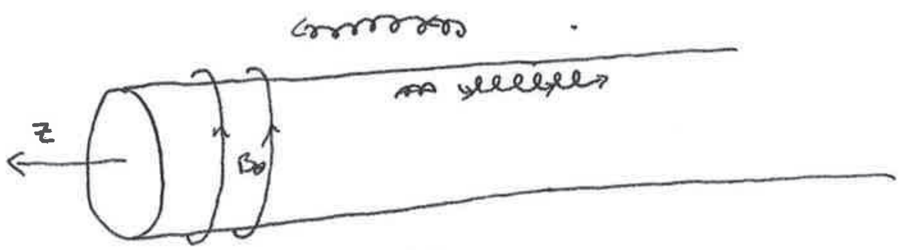
∇B

b) For $E=0$ and no azimuthal velocity, only the curvature drift is present.

$$V_{\nabla B} = \frac{W_\perp}{q} \frac{B \times \nabla B}{B^3}$$

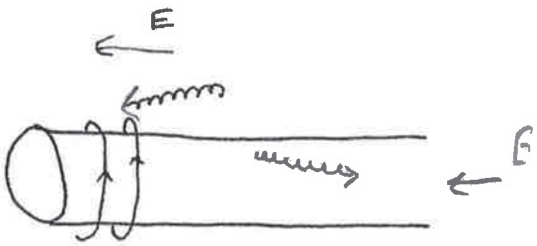
For $r < r_0$, $B_{+\hat{\theta}} \times \nabla B_{+\hat{r}} = -\hat{z}$

$r > r_0$, $B_{+\hat{\theta}} \times \nabla B_{-\hat{r}} = +\hat{z}$



Ions circle left handed.

) $E>0$ gives us an $E \times B$ drift. Both particles drift radially inward.



$V_{E \times B} \sim \frac{E}{B}$, so will get faster as B gets smaller.

d) Yes, both ions drift inward. A $V_0 = 0$, $r=0$, the particle will accelerate along z. With some small $V_0 = V_r$, it will "bounce" up and down