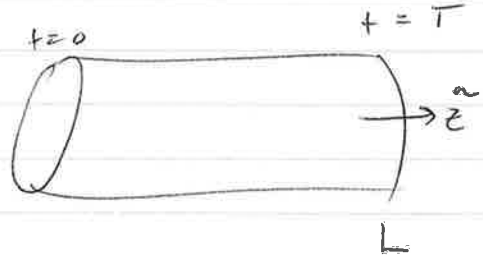
jlle~~B~~3

a. $2\pi r B = \mu_0 \pi r^2 I$

$B = \frac{\mu_0 I}{2} r \hat{\phi}$

b.



$\vec{F} = q\vec{v}\times\vec{B} = \frac{q v \mu_0 I}{2} r(-\hat{r})$

$\ddot{r} = -\frac{q v \mu_0 I}{2m} r \rightarrow r = r_0 \cos at$

$\dot{r} = -r_0 a \sin at$

with $a = \sqrt{\frac{q v \mu_0 I}{2m}}$

monoenergetic, all exit tube at $T = \frac{L}{v}$.

at this time, $r(T) = r_0 \cos aT$, $\dot{r}(T) = -r_0 a \sin aT$.

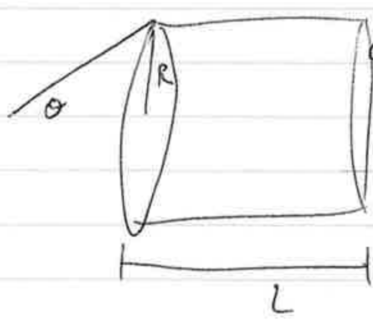
at some later time, $r(t) = r(T) + \dot{r}(T) t$

$0 = r_0 \cos aT - r_0 a \sin aT\, t'$

$\rightarrow t' = \frac{\cos aT}{a \sin aT}$ is when a particle reaches $r=0$, regardless of its initial radial position r_0.

the focal length is $D = \frac{v}{t'} = \frac{a v \sin aT}{\cos aT}$ $a = \sqrt{\frac{q v \mu_0 I}{2m}}$

c.



$\theta \approx \tan\theta = \frac{R}{D} = \frac{R}{v}\sqrt{\frac{2m}{q v \mu_0 I}}\ \frac{\sin aT}{\cos aT}$

$\tan aT = \tan\left(L\sqrt{\frac{q \mu_0 I}{2mv}}\right) \approx L\sqrt{\ }$