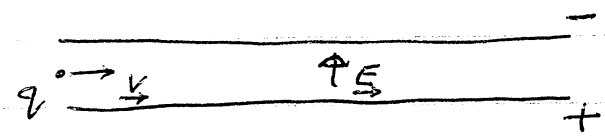
TEST QUESTIONS – EXAM II (2ND INSTALLMENT)

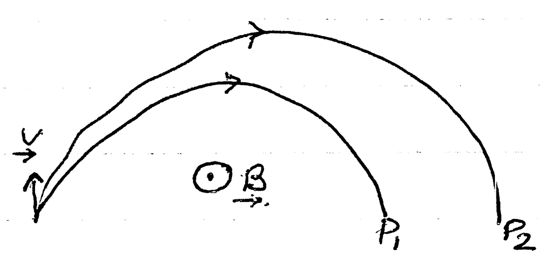
1. Two parallel plates have a uniform $\vec{E} = E\hat{y}$ between them. Introduce a particle of charge q travelling at $\vec{v} = v\hat{x}$. What $\vec{B}$ field would you apply so that the particle goes through the plates undeflected?



2. A proton with a velocity of 100 km/s $\hat{y}$ is introduced in a region where there is a $\vec{B}$ field of $0.5\,T\,\hat{z}$. Show that the proton will move on a circular orbit in the xy-plane. Calculate the radius of the orbit and the angular velocity of the proton. [$q = 1.6\times10^{-19}$C, $m_p = 1.6\times10^{-27}$ kg].

3. Repeat prob 2 with an electron. [$q = -1.6\times10^{-19}$C, $m_e = 9\times10^{-31}$ kg].

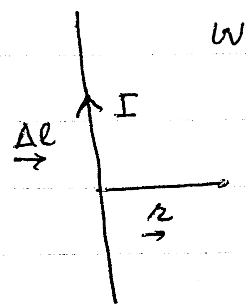
4. Shown are the paths of two particles in a mass spectrometer.



Both have same initial vel. $\vec{v} = v\hat{y}$. For the $\vec{B}$ field shown ($\vec{B} = +B\hat{z}$) what is the sign of the charge on the particles?

(i) In Case I both particles have same charge but different masses M_2 and M_1. Where will the larger mass land, at P_1 or at P_2? Why?

(ii) In Case II both have same mass but different charges. Where will the larger charge land? Why?

5. 

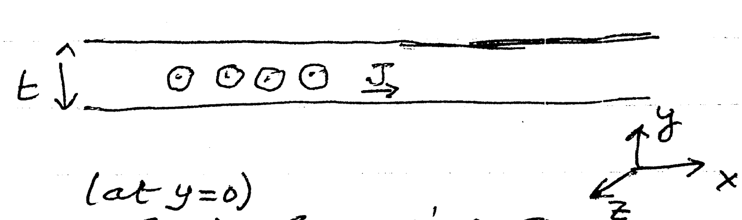
We are told that a current I creates a $\vec{B}$ field at the point $\vec{r}$ given by

$$\Delta \vec{B} = \frac{\mu_0}{4\pi} I \frac{\vec{\Delta l} \times \vec{r}}{r^3}$$

where $\vec{\Delta l}$ is the length of the conductor. Show that the $\vec{B}$ field circulates around the current.

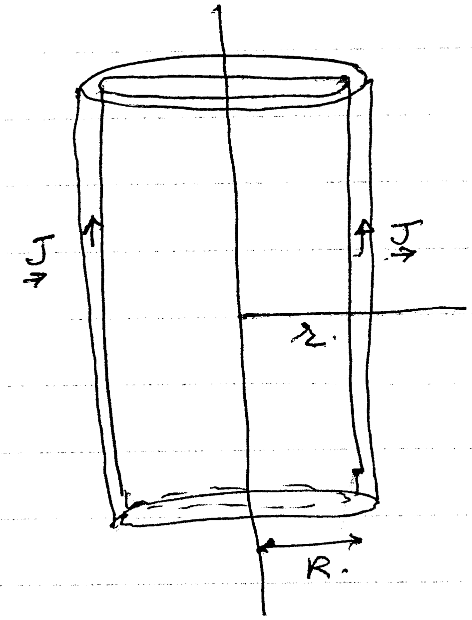
6. State Ampere's Law in your own words.

7. Shown is a large sheet of conductor of thickness t. The sheet is in the ~~xy~~ xz-plane, and carries a current density $\vec{J} = -J\hat{z}$. Show that if we go from $y<0$ to $y>0$, the $\vec{B}$ field changes from $-\frac{\mu_0 J t}{2}\hat{x}$ to $\frac{\mu_0 J t}{2}\hat{x}$.



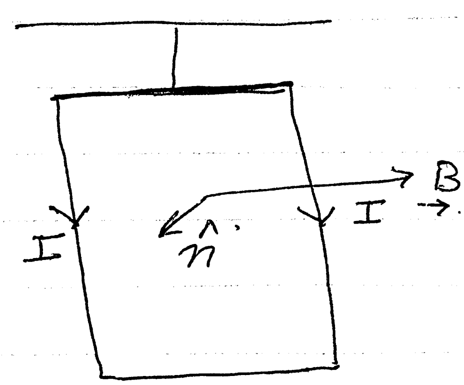
8. Let us bend the sheet into a cylindrical shell of radius R ($\gg t$). ~~Show that as~~ and make the axis at $r=0$. [See Figure].

Show that as r goes from $r<R$ to $r>R$, the $\vec{B}$ field jumps by $\mu_0 J t$.
[When you cross a current sheet $\vec{B}$ field jumps].



9. Show that parallel currents attract and antiparallel currents repel one another.

10. A rectangular coil is suspended from the ceiling. There is a uniform $\vec{B} = B\hat{x}$. If a current I is driven through the coil what would you observe? Why?



11. Why does Gauss' Law for a $\vec{B}$-field tell you that the total flux of $\vec{B}$ through any closed surface is zero?