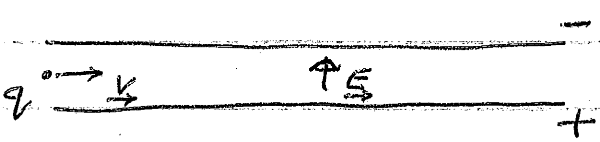
TEST QUESTIONS – EXAM III (2ND INSTALLMENT)

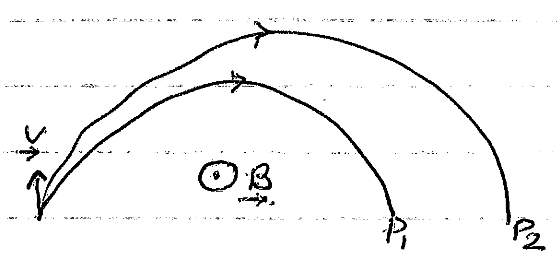
1. Two parallel plates have a uniform $\vec{E} = E\hat{y}$ between them. Introduce a particle of charge q travelling at $\vec{v} = v\hat{x}$. What $\vec{B}$ field would you apply so that the particle goes through the plates undeflected?



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 $0.5T\,\hat{z}$. 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].

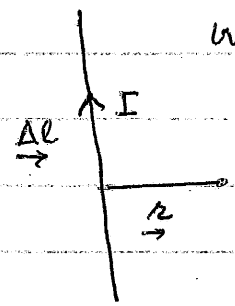
4. Shown are the paths of two particles in a mass spectrometer.



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. 

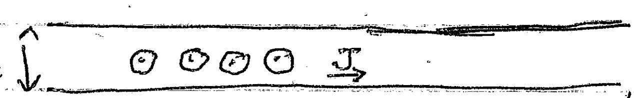
We are told that a Current I creates a $\vec{B}$ field at the point $\vec{r}$ given by

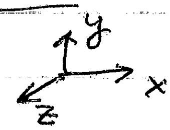
$$\vec{\Delta B} = \frac{\mu_0}{4\pi} I \frac{\vec{\Delta l} \times \vec{r}}{r^3}$$

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.

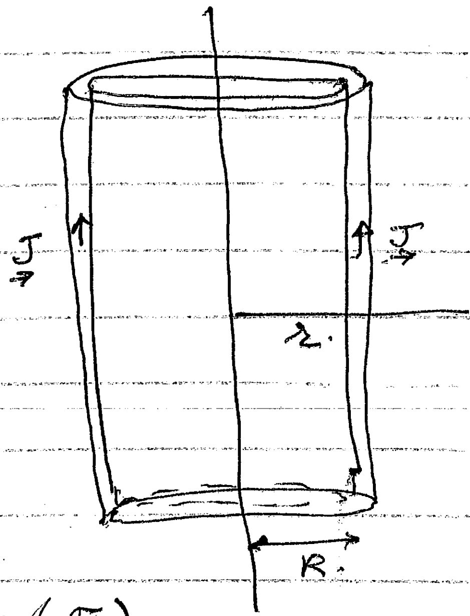
7. Shown is a large sheet of Conductor of thickness t. The sheet is in the ~~xy~~ xz - plane (at $y=0$), and carries a current density $\vec{J} = -J\hat{z}$. Show that if we go from $y<0$ to $y>0$, the $\vec{B}$ field changes from $-\frac{\mu_0 J t}{2}\hat{x}$ to $\frac{\mu_0 J t}{2}\hat{x}$.





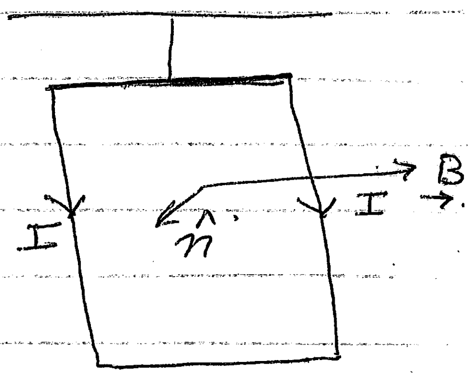
8. Let us bend the sheet into a Cylindrical shell of radius R ($\gg t$). ~~Show that as~~ and make the axis at $r=0$. [See Figure].

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] ($\mu_0 J t$)
[When you cross a sheet of charge $\vec{E}$ field jumps ($\frac{\sigma}{\varepsilon_0}$)



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

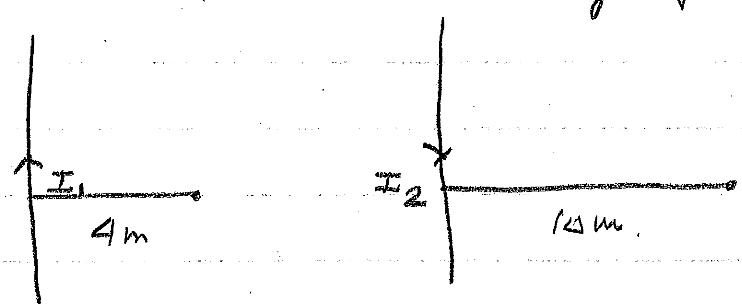
10. A rectangular Coil is suspended from the ceiling. There is a uniform $\vec{B} = B\hat{x}$. If a current I is driven through the coil what would you observe? Why?



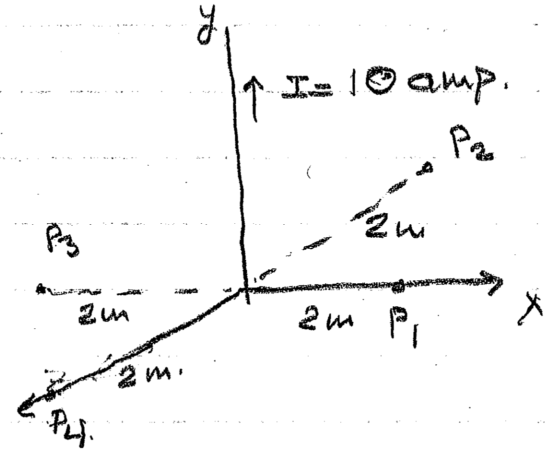
11. What are the elementary generators of a $\vec{B}$ field?

12. How would you use the coil of problem 10 to make a motor? [Assume that the coil is free to rotate about the vertical axis]

13. Currents $I_1 = 2$ amp and $I_2 = -5$ amp flow through long straight wires. Which $\vec{B}$ field will be larger (i) at $r = 4$m away from I_1 or (ii) at $r = 10$ m away from I_2?



14. Write down the magnitudes and directions of $\vec{B}$ fields at P_1, P_2, P_3, P_4.



15. Write down Gauss' Law for a $\vec{B}$-field. What does it tell you about the elementary sources of $\vec{B}$ fields? Why?

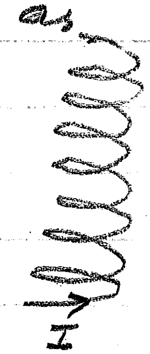
16. What is a bar magnet? Given that a single electron is a "bar magnet" how do you "build" a bar magnet conceptually.

17. What is the difference between a Coulomb $\vec{E}$-field and a non-Coulomb $\vec{E}$-field? Which of them can give rise to a <u>Non-Zero</u> value for the total flux of $\vec{E}$ through a closed surface? Why?

18. Use Ampere's law to show that in a long, narrow, solenoid ($r \ll l$) the $\vec{B}$ field inside can be written as

$$\vec{B} = \mu_0 n I \hat{y}$$

for the current direction shown.

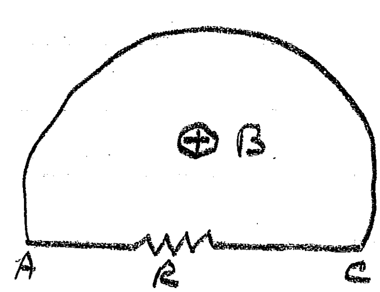


19. What is wrong with the equation

$$\sum_c \vec{E}_{NC} \cdot \Delta \vec{l} = \frac{\Delta \Phi_B}{\Delta t}$$

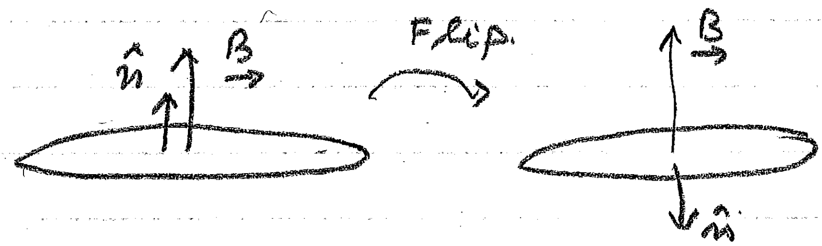
where $\frac{\Delta \Phi_B}{\Delta t}$ is the time rate of change of the flux of $\vec{B}$.

20. The picture shows a loop and resistor placed in a uniform $\vec{B}$ field, $\vec{B} = -B\hat{z}$. If magnitude of $\vec{B}$ reduces

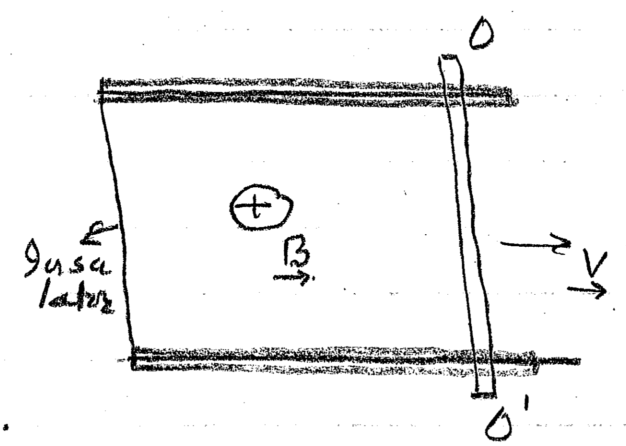


with time what is the direction of the current in R? Why?

21. A coil of wire of Area A and Resistance R is flipped in a $\vec{B}$ field from $\hat{n} \parallel \vec{B}$ to $\hat{n} \parallel -\vec{B}$. Show that during this experiment a charge $q = \frac{2BA}{R}$ travels around the coil.



22. A copper bar of length l is sliding along two conducting rails at a velocity of $+v\hat{x}$ in the presence of a uniform $\vec{B} = -B\hat{z}$.



What is the emf developed between O' & O? Which pt. is positive O' or O? If the rails are frictionless do you need to apply a force to move the bar? Why?