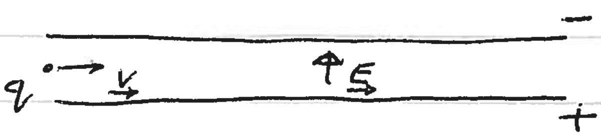
TEST QUESTIONS - EXAM II (2ND INSTALLMENT)

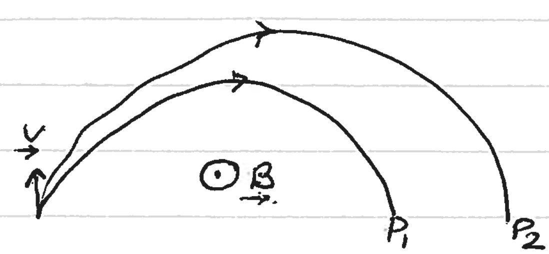
1. Two parallel plates have a uniform $\underset{\sim}{E} = E\hat{y}$ between them. Introduce a particle of charge q travelling at $\underset{\sim}{v} = v\hat{x}$. What $\vec{B}$ field would you apply so that the particle goes through the plates undeflected?



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.

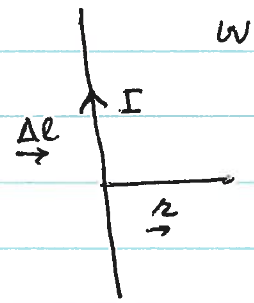


Both have same initial vel. $\underset{\sim}{v} = v\hat{y}$. For the $\vec{B}$ field shown ($\vec{B} = +B\hat{z}$) what is the sign of the charge on the particles?

(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.



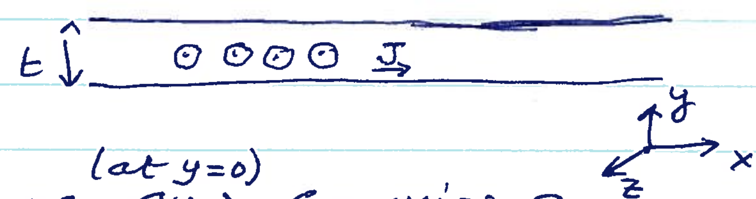
We are told that a current I creates a B field at the point $\vec{r}$ given by

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

where $\Delta \vec{l}$ 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.

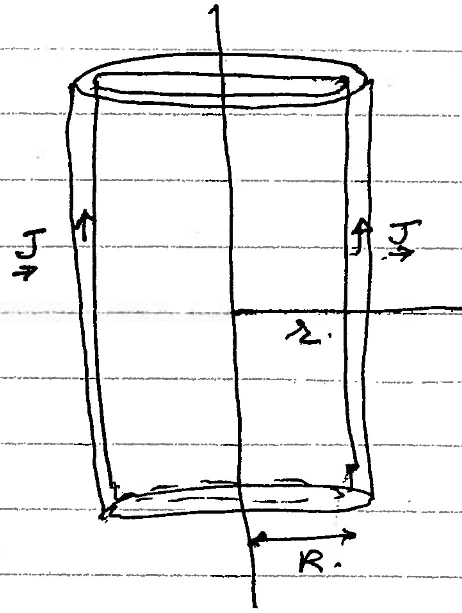
7. Shown is a large sheet of conductor of thickness t. The



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 $\frac{\mu_0 J t}{2}\hat{x}$.

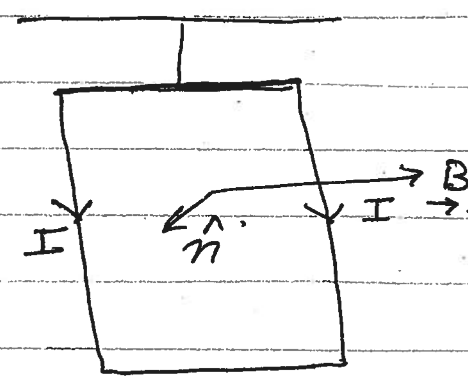
8. Let us bend the sheet into a cylindrical shell of radius R ($\gg t$). ~~Show that~~ and make the axis at $r=0$. [See Figure].

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].



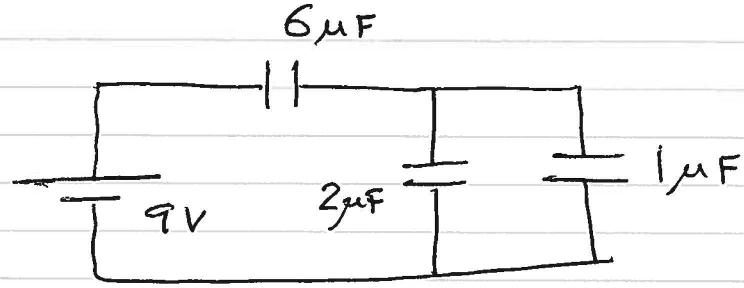
9. Show that parallel currents attract and antiparallel currents repel one another.

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

12. In the circuit shown



i) which capacitor has the highest potential?

ii) which capacitor has the least charge?

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? Why?

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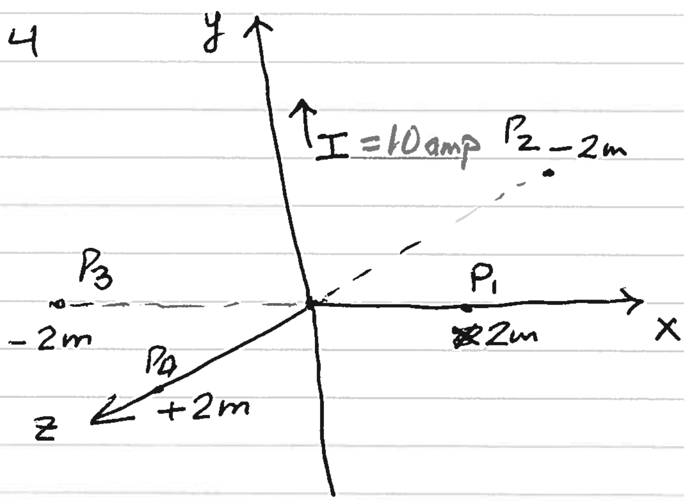

Write down the $\vec{B}$-field at P_1, P_2, P_3, P_4. Write both magnitude and direction.

15 How would you use the set up of problem 10 to run a d.c. Motor? Why?

16. What is the difference between a Coulomb $\vec{E}$ field and a non-Coulomb $\vec{E}$-field?

17. What is wrong with the Equation

$$\sum_c \vec{E}_{NC} \cdot \Delta \vec{\ell} = \frac{\Delta \phi_B}{\Delta t}$$

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

18. Why is the total flux of the $\vec{B}$ field through any closed surface always equal to zero?

19. In writing Gauss's laws we use "total flux of $\vec{E}$ or $\vec{B}$ through a closed surface" while in Ampere's law and Faraday-Lenz's law we use "circulation of $\vec{B}$ or $\vec{E}_{NC}$ around a closed loop". Why?

20. How do mass and charge help you to discover the three fields, G_F, $\vec{E}$ and $\vec{B}$? Explain.