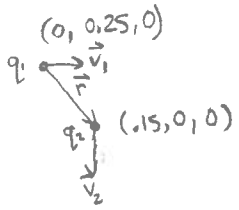
HW #11 Solutions

#1



$$\vec{B}_1 = \frac{\mu_0}{4\pi}\frac{q_1\vec{v}_1 \times \vec{r}}{r^3} = \frac{4\pi\times10^{-7}}{4\pi}(4.8\times10^{-6})\frac{[9.2\times10^5, 0, 0]\times[.15, -.25, 0]}{(.292)^3}$$

$$r = \sqrt{(.15)^2 + (.25)^2} = 0.292$$

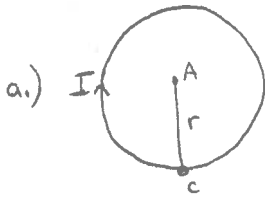
$$= \boxed{-4.5\times10^{-6}\ T\ \hat{k}}$$

$$\vec{F} = q_2\vec{v}_2 \times \vec{B}_1 = (-3.1\times10^{-6})(-5.3\times10^5\ \hat{j} \times -4.5\times10^{-6}\ \hat{k})$$

$$= \boxed{-7.3\times10^{-6}\ N\ \hat{i}}$$

#2

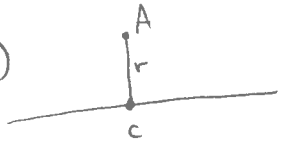
a.)



for magnetic field @ center of ring of current

$$B = \frac{\mu_0 I}{2r} = \boxed{\frac{\mu_0 I}{D}}$$

b.)



for magnetic field due to line of current at point A a distance x away:

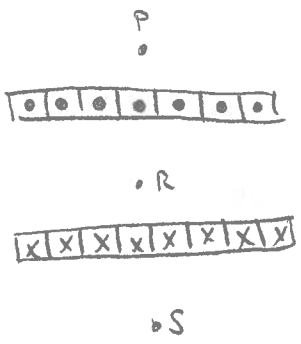
$$B = \frac{\mu_0 I}{4\pi x}\frac{L}{\sqrt{x^2 + \left(\frac{L}{2}\right)^2}} \qquad L = \pi D \qquad x = \frac{D}{2} = r$$

$$= \frac{\mu_0 I}{4\pi\frac{D}{2}}\frac{\pi D}{\sqrt{\left(\frac{D}{2}\right)^2 + \left(\frac{\pi D}{2}\right)^2}}$$

$$= \frac{\mu_0 I}{2}\frac{1}{\frac{D}{2}\sqrt{1+\pi^2}} = \frac{\mu_0 I}{D\sqrt{1+\pi^2}}$$

c.) By distorting the path of current from a ring to a ring, there is more moving charge closer to the point A which accounts for the larger magnetic field.

#3



For current going into page ⊙ the magnetic field points:

P - left

R - right

S - right

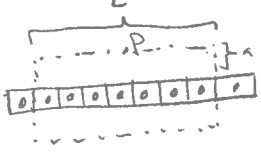
For current going out of the page ⊗ the magnetic field points:

P - right

R - right

S - left

to calculate magnitude of magnetic field:



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

on the sides $\oint \vec{B} \cdot d\vec{l} = 0$ because B is parallel to the sheet.

on the top + Bottom

$$\oint \vec{B} \cdot d\vec{l} = 2BL = \mu_0 I_{enc} \quad I_{enc} = InL$$

$$\Rightarrow 2BL = \mu_0 InL$$

$$\Rightarrow \underline{B = \tfrac{1}{2}\mu_0 In}$$

a,c.) at points P & S, the magnetic fields oppose and so they cancel since the field does not depend on the distance away from the sheets.

b.) at R the fields add

$$B = \tfrac{1}{2}\mu_0 In + \tfrac{1}{2}\mu_0 In = \boxed{\mu_0 In}$$ and points <u>right</u>