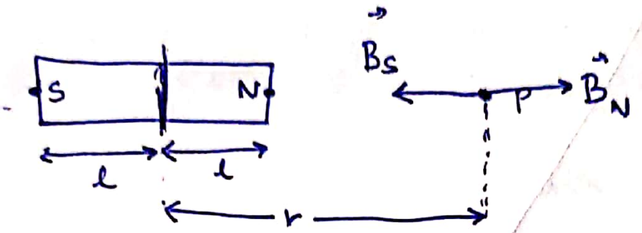
Name: .... Subject: .... Reg. No.: ....

→ Magnetic field due to ▭ @ ~~axial~~ ~~equatorial~~ axial   Date: ....



$$\vec{B}_{axial} = \vec{B}_N + \vec{B}_S$$

$$\frac{F}{q_m} = \frac{\mu_0 q_m \cancel{q_m}}{4\pi\, \cancel{q_m}}$$

$$= \frac{\mu_0 q_m}{4\pi}\left(\frac{1}{(r-l)^2} - \frac{1}{(r+l)^2}\right)$$

$$= \frac{\mu_0 q_m}{4\pi}\left(\frac{r^2+l^2+2rl - r^2 - l^2 + 2rl}{((r-l)(r+l))^2}\right)$$

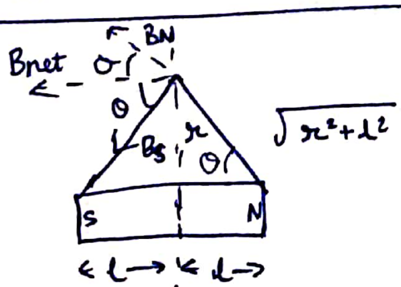
$$= \frac{\mu_0 q_m}{\cancel{4}\pi}\left(\frac{\cancel{4}rl}{(r^2-l^2)^2}\right)$$

$$= \frac{\mu_0 q_m r l}{\pi(r^2-l^2)^2} = \frac{\mu_0 m r}{2\pi(r^2-l^2)^2}$$

If $r >> l$

$$B_{axial} = \frac{\mu_0 \vec{m} r}{2\pi r^4} = \frac{\mu_0 m}{2\pi r^3} = \frac{\mu_0}{4\pi}\cdot\frac{2\vec{m}}{r^3} \quad -①$$

→ Magnetic field due to ▭ @ equatorial



$\vec{B}_{equatorial} = \vec{B}_{S\theta} + \vec{B}_N$ $\quad$ ($\because$ ~~sin~~ θ vertical comps are cancelled out)

$= B_S \cos\theta + B_N \cos\theta$

$= \left(\frac{\mu_0}{4\pi} \frac{\cancel{q_m} m}{r^2+l^2} + \frac{\mu_0}{4\pi} \frac{m}{r^2+l^2}\right) \cos\theta$

2) $= \frac{2\mu_0}{4\pi}\left(\frac{m}{r^2+l^2}\right) \cos\theta$

$\cancel{= \frac{2\mu_0 m}{4\pi(r^2+l^2)} = \left(\frac{\mu_0 m}{2\pi(r^2+l^2)}\right)} \cos\theta$

~~If $r >> l$~~

$\cancel{\vec{B}_{equatorial} = \frac{\mu_0 m}{2\pi r^2}}$

$= \frac{2\mu_0 q_m}{4\pi(r^2+l^2)} \times \frac{l}{\sqrt{r^2+l^2}}$

$= \frac{2\mu_0 q_m l}{4\pi(r^2+l^2)^{3/2}}$

$= \frac{\mu_0 m}{4\pi(r^2+l^2)^{3/2}}$

If $r >> l$

$= \frac{\mu_0 m}{4\pi(r^2)^{3/2}} = \frac{\mu_0 m}{4\pi r^3}$ $\quad$ —(2)

From (1) & (2)

$\vec{B}_{equatorial} \times 2 = \vec{B}_{axial}$