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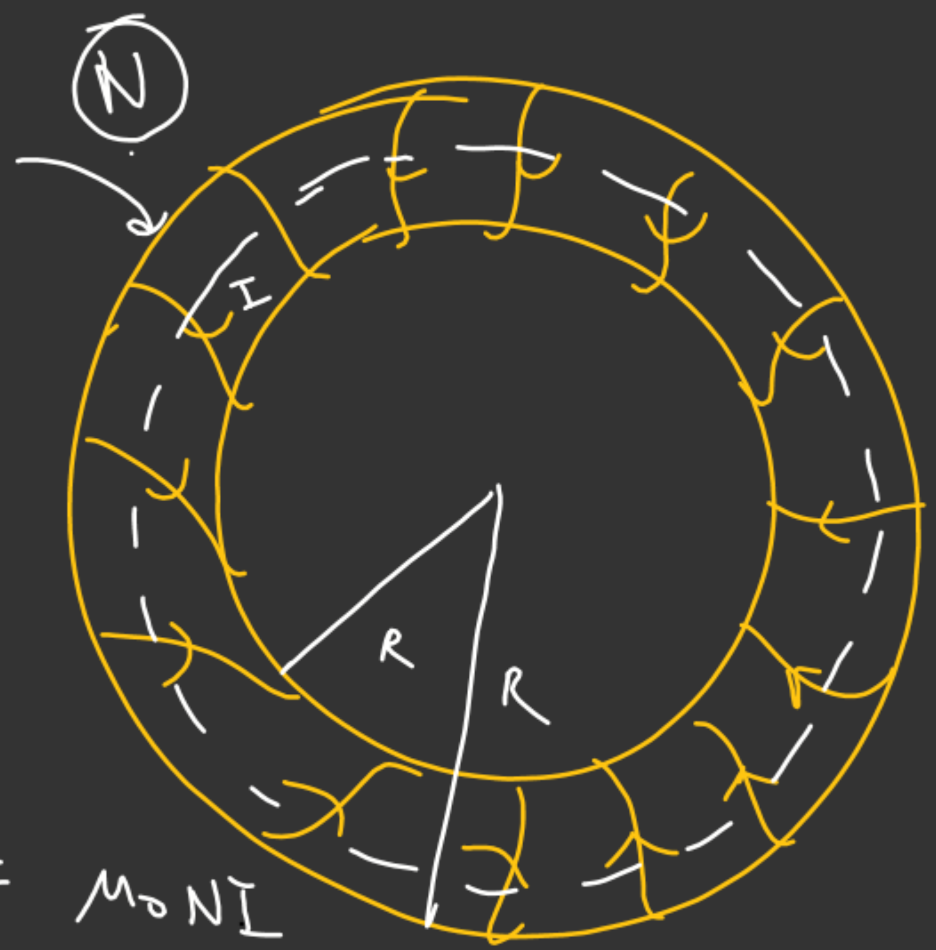
TORIOD



$$B \cdot 2\pi R = \mu_0 N I$$

$$B = \left(\frac{\mu_0 N I}{2\pi R}\right)$$

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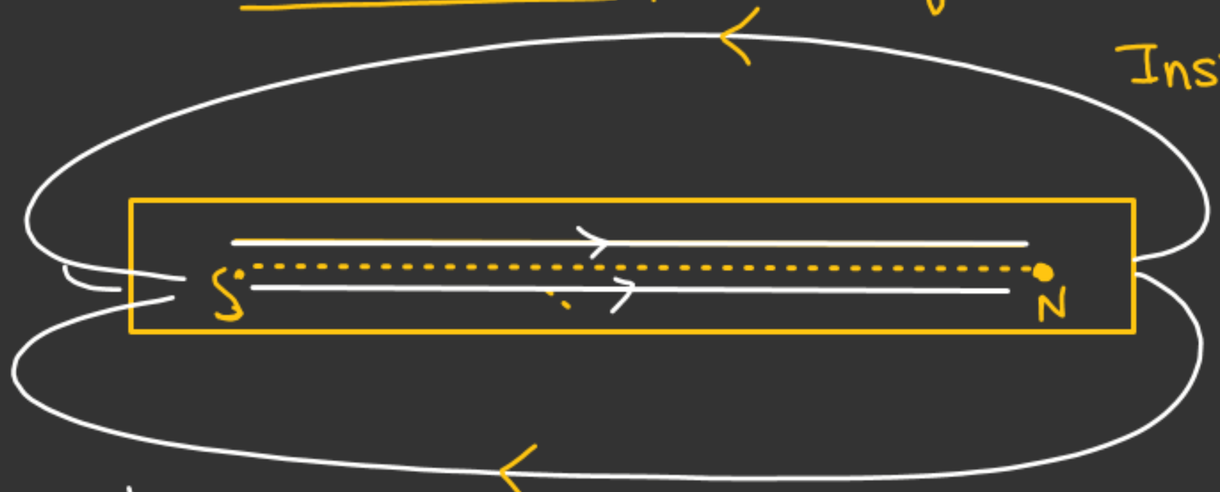
MAGNETISM [JEE Mains]

(※) Magnet



Magnetic axis :- Line joining South and North pole.

Magnetic Meridan :- The plane in which freely suspended Magnet lies that plane is called Magnetic Meridian

(※) Magnetic field lines

- Always exit from North pole and entered in South pole.
- Always form a closed loop.
- Tangent to Magnetic field lines gives direction of Magnetic field
- Two Magnetic-field never intersect
- The Intensity of Magnetic field lines is proportional to Magnetic field strength.

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Pole strength → S.I Unit → Ampere-meter (A-m)

$-q \leftarrow 2l \rightarrow +q$

$\downarrow$ (−m) $\quad$ $\downarrow$ (+m)

$p = (q\,2L)$

↓

(Dipole Moment)

[Shortest distance b/w S and N]

For South pole strength → (−m)

For North pole strength → (+m)

Magnetic Moment

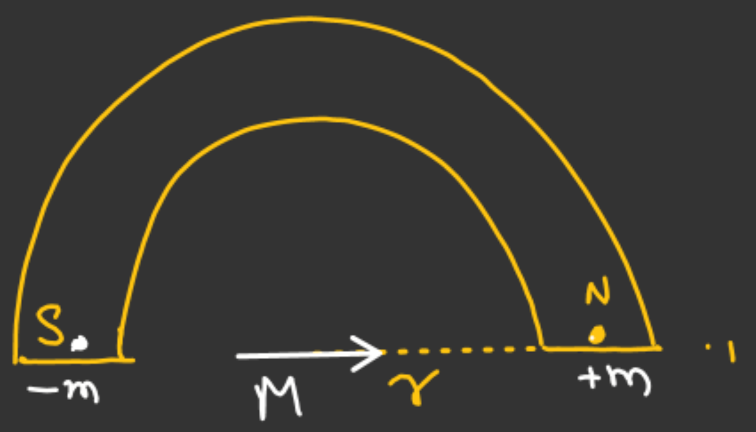
↳ (Pole strength) × (Distance b/w the pole)

$$\boxed{M = m(2l)}$$

⇒ (Direction always from South to North)

S.I Unit ⇒ $(A\text{-}m^2)$

#



$M = (m \cdot 2r)$

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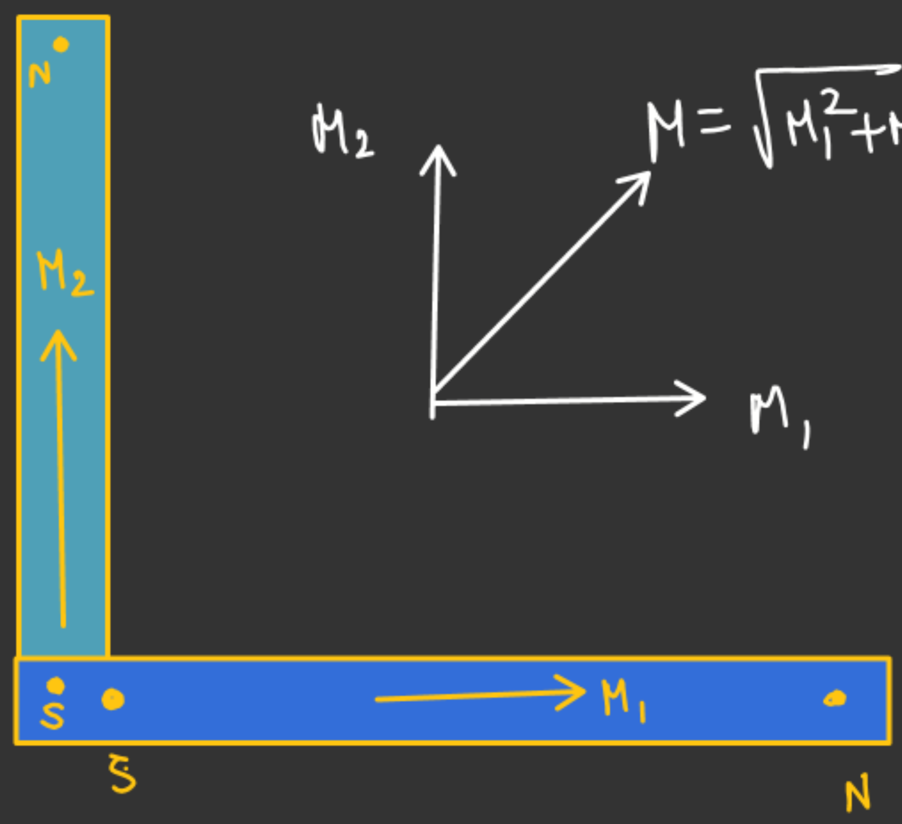
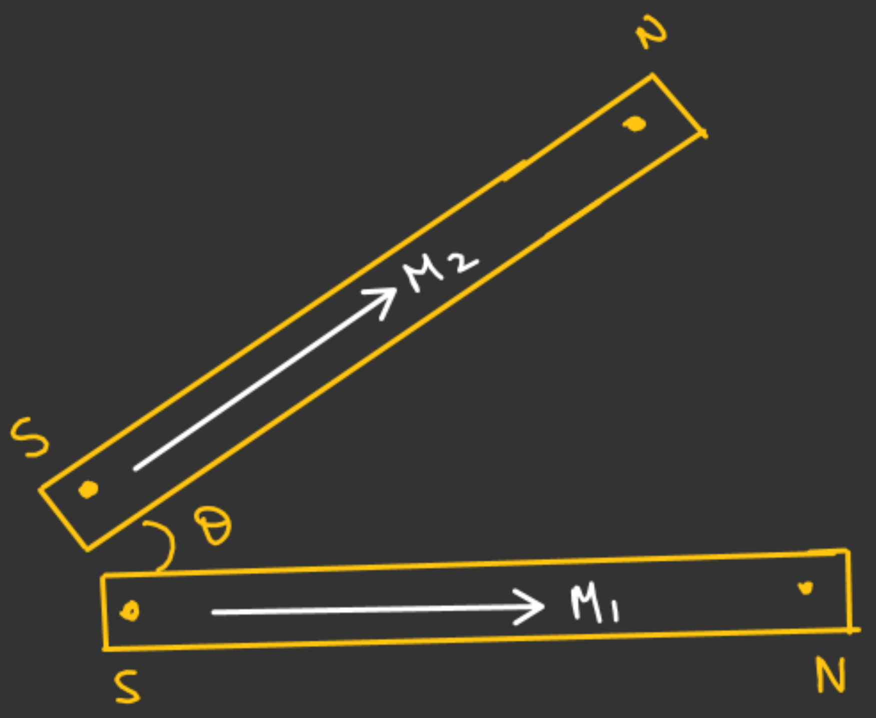
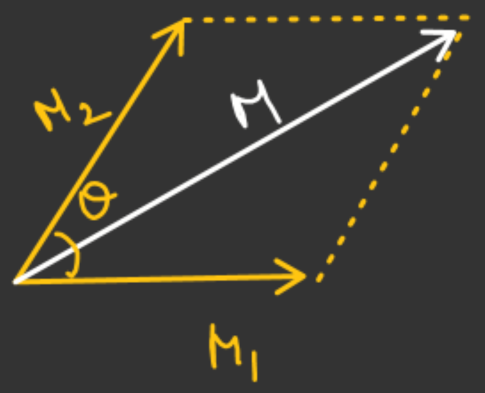


$$M = \sqrt{M_1^2 + M_2^2}$$





$$M = \sqrt{M_1^2 + M_2^2 + 2M_1M_2\cos\theta}$$

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Effect of Magnetic Moment due to Cutting of bar Magnet :→

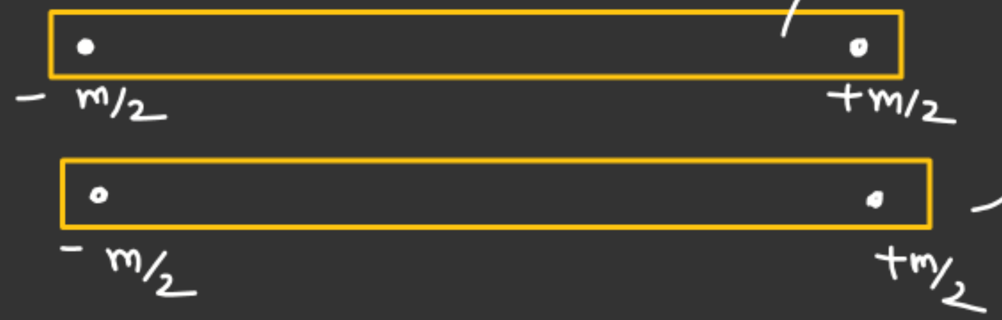
Front View

Cutting

$M = (m2\ell)$

$M' = \frac{m}{2}\cdot(2\ell)$

$M' = \frac{M}{2}$



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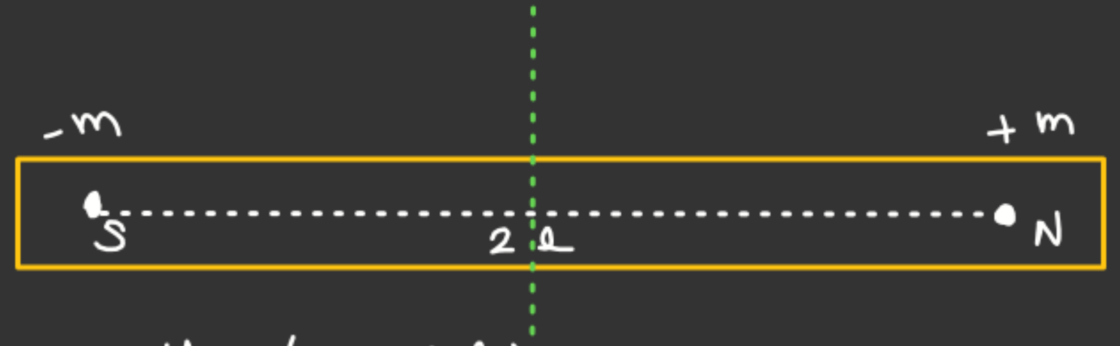
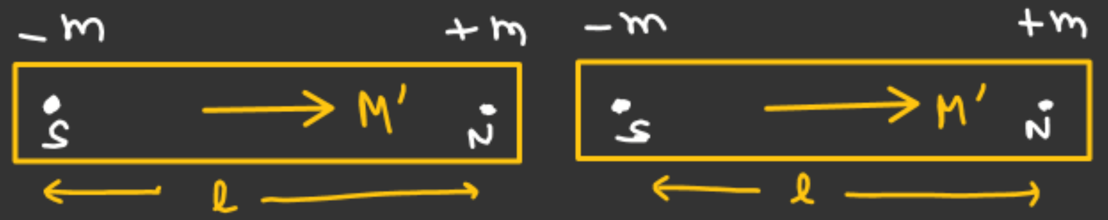
(*) Cutting along the length.



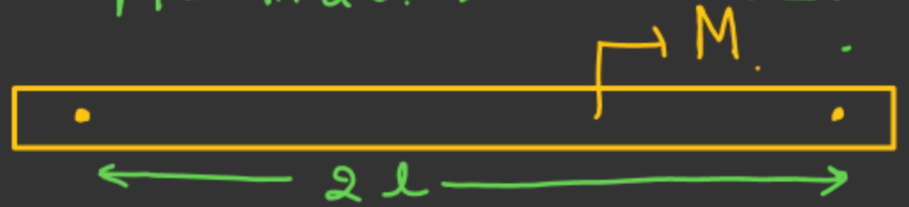
$M = (m \cdot 2l)$



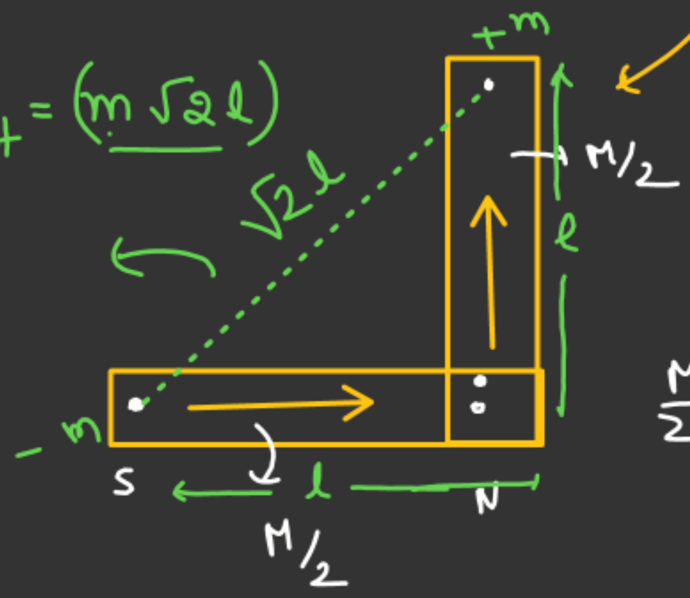
$M' = (m\, l)$

$\left(M' = \frac{M}{2}\right)$

$M = m \cdot 2l \Rightarrow ml = \left(\frac{M}{2}\right)$



After bending from the Mid point Find Magnetic Moment.

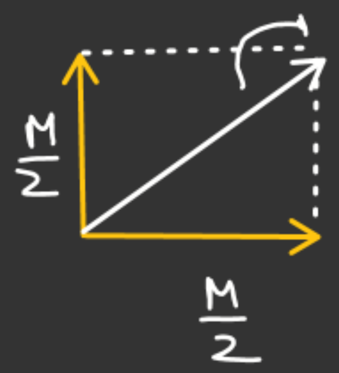


$M_{net} = (m\sqrt{2}\,l)$

$M_{net} = (ml)\sqrt{2}$

$= \frac{M}{2} \times \sqrt{2}$

$= \left(\frac{M}{\sqrt{2}}\right)$



$M_{net} = \sqrt{\frac{M^2}{4} + \frac{M^2}{4}}$

$= \sqrt{\frac{M^2}{2}}$

$= \frac{M}{\sqrt{2}}$ ✓

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44: Magnetic field due to a mono-pole

N

+m .... → B

$$\vec{B}_{+m} = \frac{\mu_0}{4\pi}\left(\frac{m}{r^2}\right)\hat{r}$$

S

−m .... $\vec{B}$ ←

$$\vec{B}_{-m} = \frac{\mu_0}{4\pi}\left(\frac{m}{r^2}\right)(-\hat{r})$$

+q .... r .... → $\vec{E}$

$$\vec{E} = \left(\frac{1}{4\pi\varepsilon_0}\right)\left(\frac{q}{r^2}\right)\hat{r}$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^3}\cdot(\vec{r})$$

−q .... $\vec{E}$ ←

$$\vec{E}_{-q} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^3}\cdot(-\vec{r})$$

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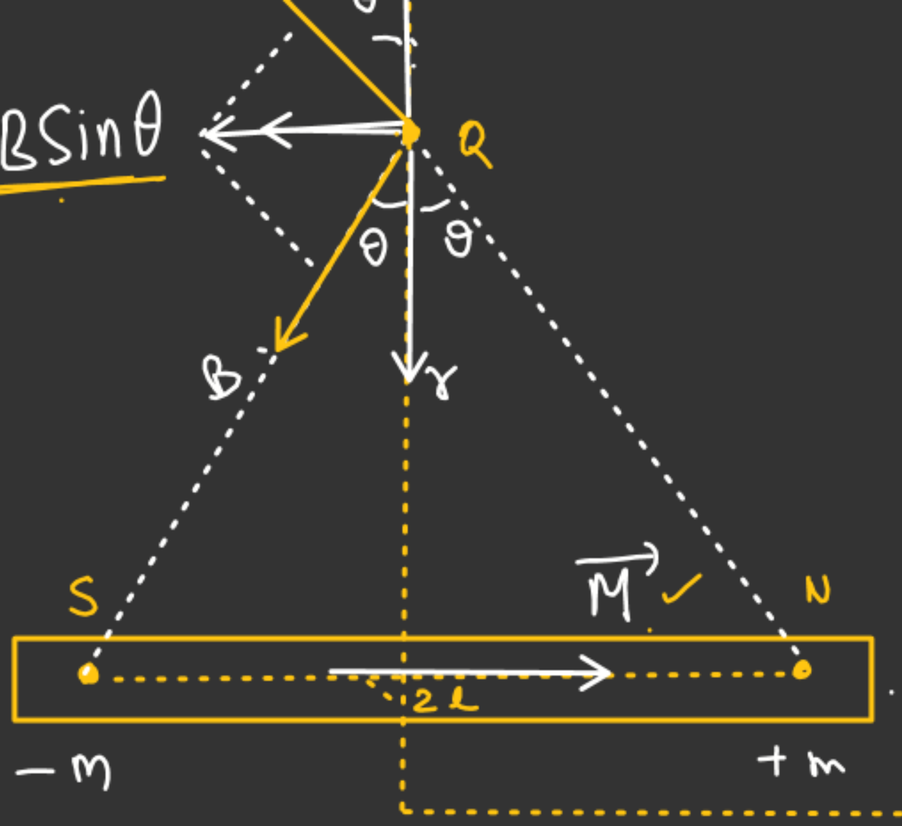
$B_Q = 2B\sin\theta$



(Axial or end on position) $\longrightarrow$ $\vec{B}_P = \frac{\mu_0}{4\pi}\left(\frac{2\vec{M}}{r^3}\right)$

$$\vec{B}_Q = \left(-\frac{\mu_0}{4\pi}\frac{\vec{M}}{r^3}\right)$$

[r<<l]

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

$M = m(2l)$

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

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

$B_Q = (2B\sin\theta)$

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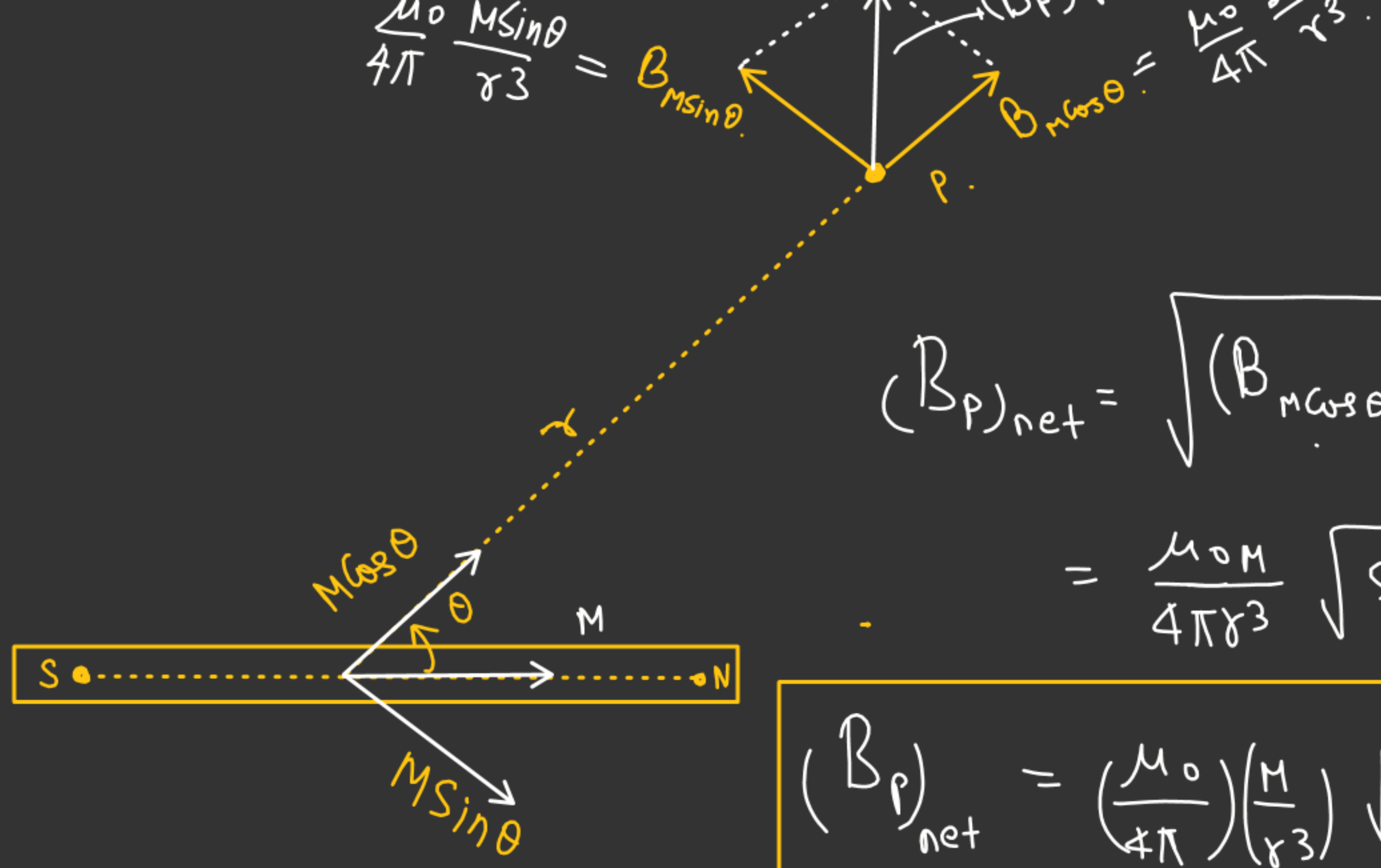

$$(B_P)_{net} = \sqrt{(B_{M\cos\theta})^2 + (B_{M\sin\theta})^2}$$

$$= \frac{\mu_0 M}{4\pi r^3}\sqrt{\sin^2\theta + 4\cos^2\theta}$$

$$\boxed{(B_P)_{net} = \left(\frac{\mu_0}{4\pi}\right)\left(\frac{M}{r^3}\right)\sqrt{1+3\cos^2\theta}}$$

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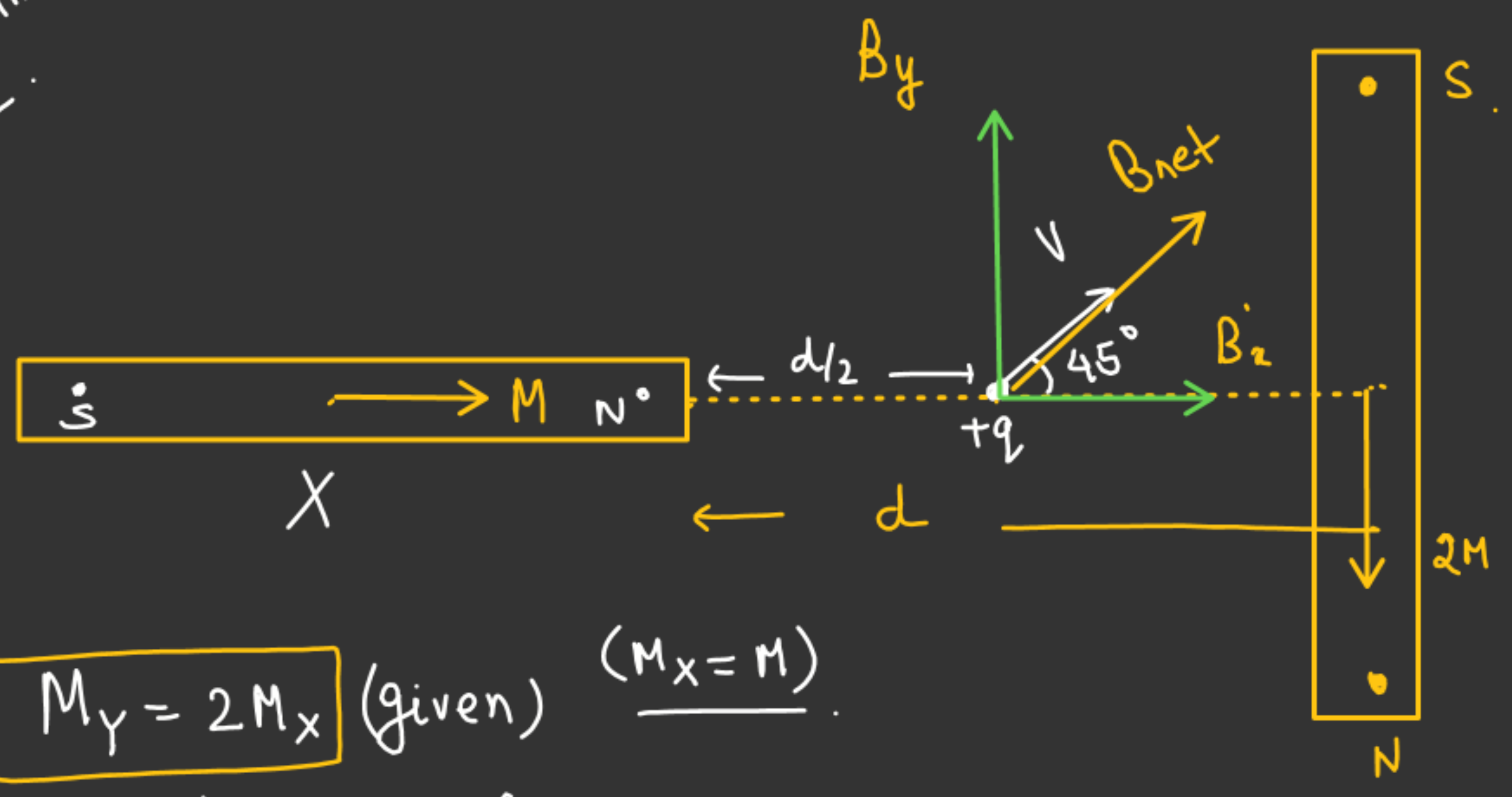
Force on (+q)

JEE-Main 2019.



$\boxed{M_Y = 2M_X}$ (given) $(M_X = M)$

Magnitude of force on q.

1) 0

2) $\sqrt{2}\,\frac{\mu_0}{4\pi}\,\frac{M}{(\frac{d}{2})^3} \times qv$

3) $\frac{\mu_0}{4\pi}\,\frac{2M}{(d/2)^3} \times qv$

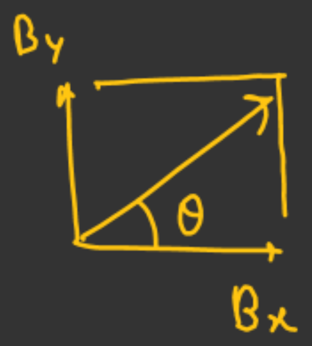
4) $\frac{\mu_0}{4\pi}\,\frac{M}{(d/2)^3} \times qv$

$$\vec{B_x} = \frac{\mu_0}{4\pi}\,\frac{2M}{(d/2)^3}\,\hat{i}$$

$$\vec{B_y} = \frac{\mu_0}{4\pi}\,\frac{2M}{(d/2)^3}\,\hat{j}$$

M_y

$$B_{net} = \sqrt{2}\left[\frac{\mu_0}{4\pi}\,\frac{2M}{(d/2)^3}\right]$$



$\tan\theta = \frac{B_y}{B_x} = 1$

$\theta = 45^\circ$

$\vec{v} \parallel \vec{B}$.

$F = 0$