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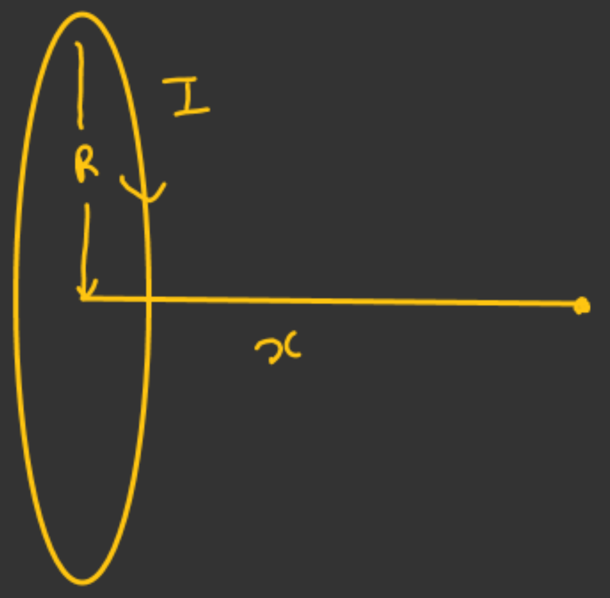


$$B_x = \frac{\mu_0 I R^2}{2(x^2+R^2)^{3/2}}$$

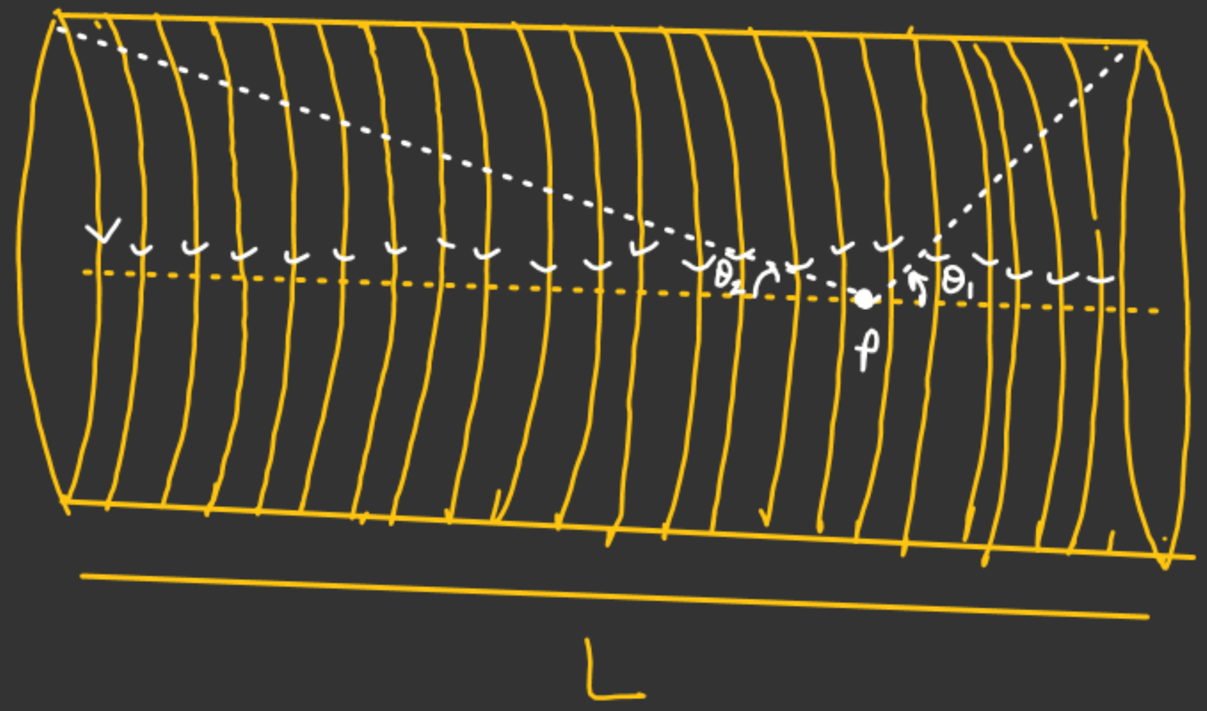
Magnetic field on the axis of a finite Solenoid on its axis

$N =$ Total No of turns

$L =$ length of the Solenoid

$n = \frac{N}{L} =$ No of turns per Unit length.

$i =$ Current in each turn.



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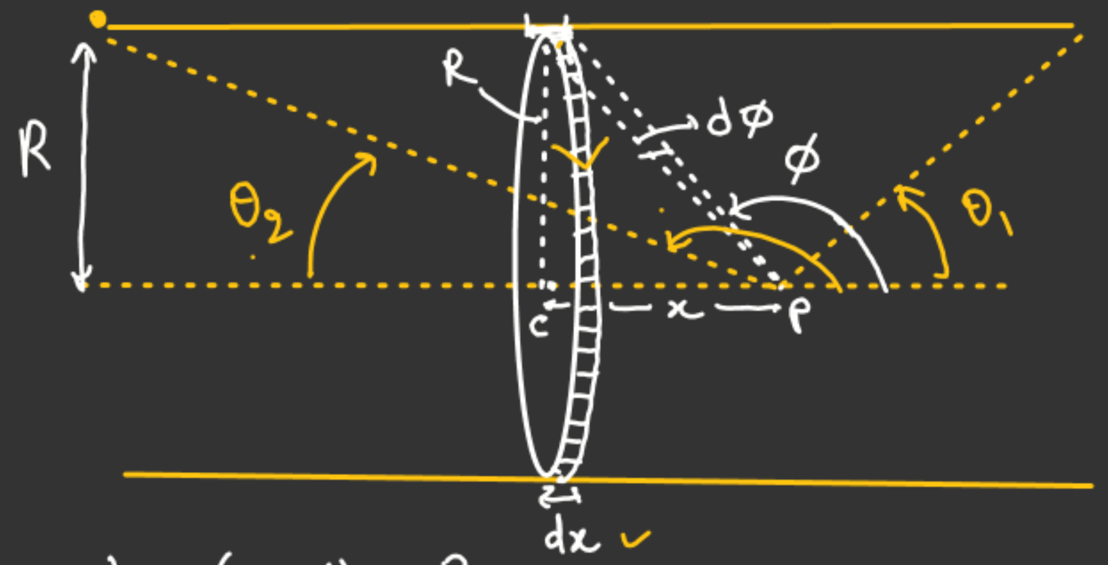
No of turns in 'dx' length = (ndx)

Total Current in the ring of dx width $= i(ndx)$

dB = Magnetic field due to ring at P

$$dB = \frac{\mu_0 (i n dx) R^2}{2(R^2+x^2)^{3/2}}$$

$\theta_2 = (\pi - \theta_1)$



$$dB = \frac{\mu_0 n i R^2}{2} \frac{(R \operatorname{Cosec}^2\phi \, d\phi)}{(R^2 + R^2 \cot^2\phi)^{3/2}}$$

$\tan(\pi-\phi) = \frac{R}{x}$

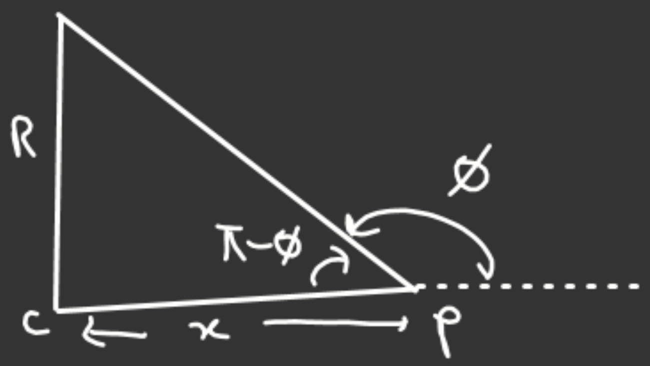
$-\tan\phi = \frac{R}{x}$

$x = -R\cot\phi$

Differentiating both Side w.r.t ϕ

$$\frac{dx}{d\phi} = -R(-\operatorname{Cosec}^2\phi)$$

$$dx = R\operatorname{Cosec}^2\phi \, d\phi$$



$$dB = \frac{\mu_0 n i \cancel{R^3}}{2\times \cancel{R^3}} \frac{\operatorname{Cosec}^2\phi \, d\phi}{\operatorname{Cosec}^3\phi}$$

$$\int_0^B dB = \frac{\mu_0 n i}{2}\int_{\theta_1}^{(\pi-\theta_2)} \sin\phi \, d\phi$$

$$B = \frac{\mu_0 n i}{2}\left[-\cos\phi\right]_{\theta_1}^{(\pi-\theta_2)} \Rightarrow \boxed{B = \frac{\mu_0 n i}{2}(\cos\theta_2 + \cos\theta_1)}$$

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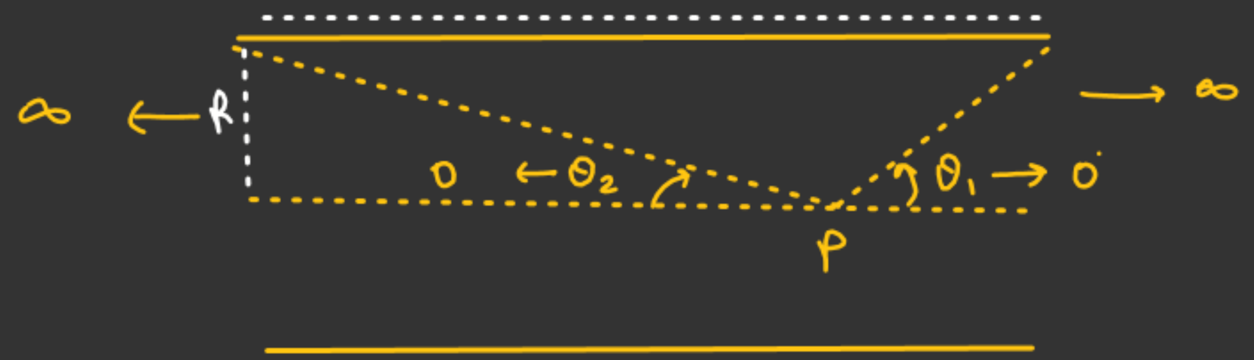
** Magnetic field on the axis of an infinite Solenoid:-



Semi infinite

$$B = \frac{\mu_0 n i}{2}\left[\cos 0° + \cos 0°\right]$$

$L >> R$

**

$$\boxed{B = \mu_0 n i}$$

$$\boxed{B_p = \frac{\mu_0 n i}{2}}$$

$n = \left(\frac{N}{L}\right)$

$$B = \mu_0 \frac{N}{L} i$$

N = Total no of turns

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Magnetic field due to a moving Charge: $\rightarrow$

$$\vec{dB} = \frac{\mu_0}{4\pi} i \left(\frac{\vec{dl} \times \vec{r}}{r^3} \right)$$

$$i = \frac{dq}{dt}$$

$$\vec{dB} = \frac{\mu_0}{4\pi} \frac{dq}{dt} \left(\frac{\vec{dl} \times \vec{r}}{r^3} \right)$$

$$\frac{\vec{dl}}{dt} = \vec{v}$$

$$\vec{dB} = \frac{\mu_0}{4\pi} dq \left(\frac{\frac{\vec{dl}}{dt} \times \vec{r}}{r^3} \right)$$

$$\boxed{\vec{dB} = \frac{\mu_0}{4\pi} dq \left(\frac{\vec{V} \times \vec{r}}{r^3} \right)}$$

For q charge moving with velocity $\vec{v}$.
magnetic field at a distance $\vec{r}$.

$$\boxed{\vec{B} = \frac{\mu_0}{4\pi} q \left(\frac{\vec{V} \times \vec{r}}{r^3} \right)}$$

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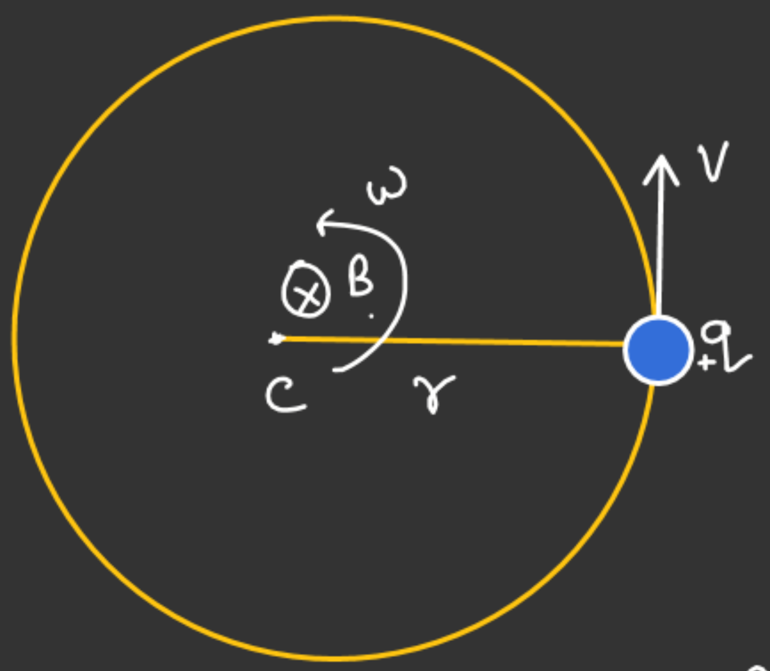
$$I = \frac{q}{T} = \frac{q\omega}{2\pi}$$ ✓



$$\vec B = \frac{\mu_0}{4\pi}\, q\left(\frac{\vec v\times\vec r}{r^3}\right) \qquad \vec v \perp \vec r$$

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

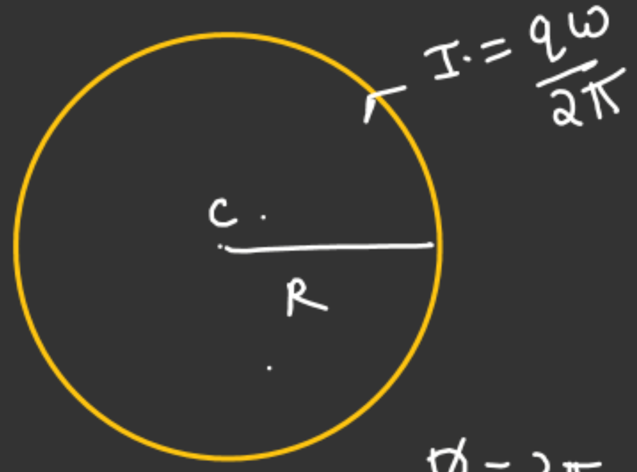
$$\underline{v = r\omega}$$

$$B = \frac{\mu_0}{4\pi}\left(\frac{q r\omega}{r^2}\right)$$

$$\boxed{B = \frac{\mu_0}{4\pi}\left(\frac{q\omega}{r}\right)}$$

$$\vec B \to \vec v\times\vec r \to (\hat j\times -\hat i)$$
$$\Downarrow$$
$$\to +\hat k$$

$$\vec r \to -\hat i$$
$$\vec v \to +\hat j$$



$$\phi = 2\pi$$

$$B = \frac{\mu_0 I}{4\pi R}(\phi)$$

$$B_c = \left(\frac{\mu_0 I}{2R}\right)$$

$$B_c = \frac{\mu_0}{2R}\times\frac{q\omega}{2\pi} \qquad I = \left(\frac{q\omega}{2\pi}\right)$$

$$B_c = \frac{\mu_0 q\omega}{4\pi R}$$ ✓

** Force of interaction b/w two moving charges :→

$$\overrightarrow{B}_{q_1} = \frac{\mu_0}{4\pi}\, q_1 \left(\frac{\vec{v}_1 \times \vec{r}}{r^3}\right)$$

$$\overrightarrow{F}_{q_2} = q_2\left(\vec{V}_2 \times \vec{B}_{q_1}\right)$$

$$\overrightarrow{F}_{q_2} = q_2\, \vec{V}_2 \times \frac{\mu_0 q_1}{4\pi}\left(\frac{\vec{v}_1 \times \vec{r}}{r^3}\right)$$

$$\overrightarrow{F}_{q_2} = \frac{\mu_0 q_1 q_2}{4\pi}\left(\vec{V}_2\right) \times \left(\frac{\vec{v}_1 \times \vec{r}}{r^3}\right)$$

$$\boxed{\left|\overrightarrow{F}_{q_2}\right| = \frac{\mu_0 q_1 q_2}{4\pi}\left(\frac{V_2 v_1 \sin\theta}{r^2}\right)} \quad -(1)$$

F_B = Magnetic force b/w two moving charge

$$F_E = \left[\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}\right] \quad -(2)$$

$$\boxed{\frac{1}{\sqrt{\mu_0\varepsilon_0}} = c}$$

$$(\vec{v}_1 \times \vec{r}) \perp \vec{V}_2$$

$$c^2 = \frac{1}{\mu_0\varepsilon_0}$$

$$\frac{F_B}{F_E} = \frac{\mu_0 q_1 q_2}{4\pi}\,\frac{v_1 v_2 \sin\theta}{r^2} \times \frac{4\pi\varepsilon_0 r^2}{q_1 q_2}$$

$$\frac{F_B}{F_E} = \left(\mu_0\varepsilon_0 v_1 v_2 \sin\theta\right)$$

$$\boxed{\frac{F_B}{F_E} = \frac{v_1 v_2 \sin\theta}{c^2}}$$

if $\theta = 90°$

$$\left(\frac{F_B}{F_E} = \frac{v_1 v_2}{c^2}\right)$$

$$(c = 3\times 10^8)$$

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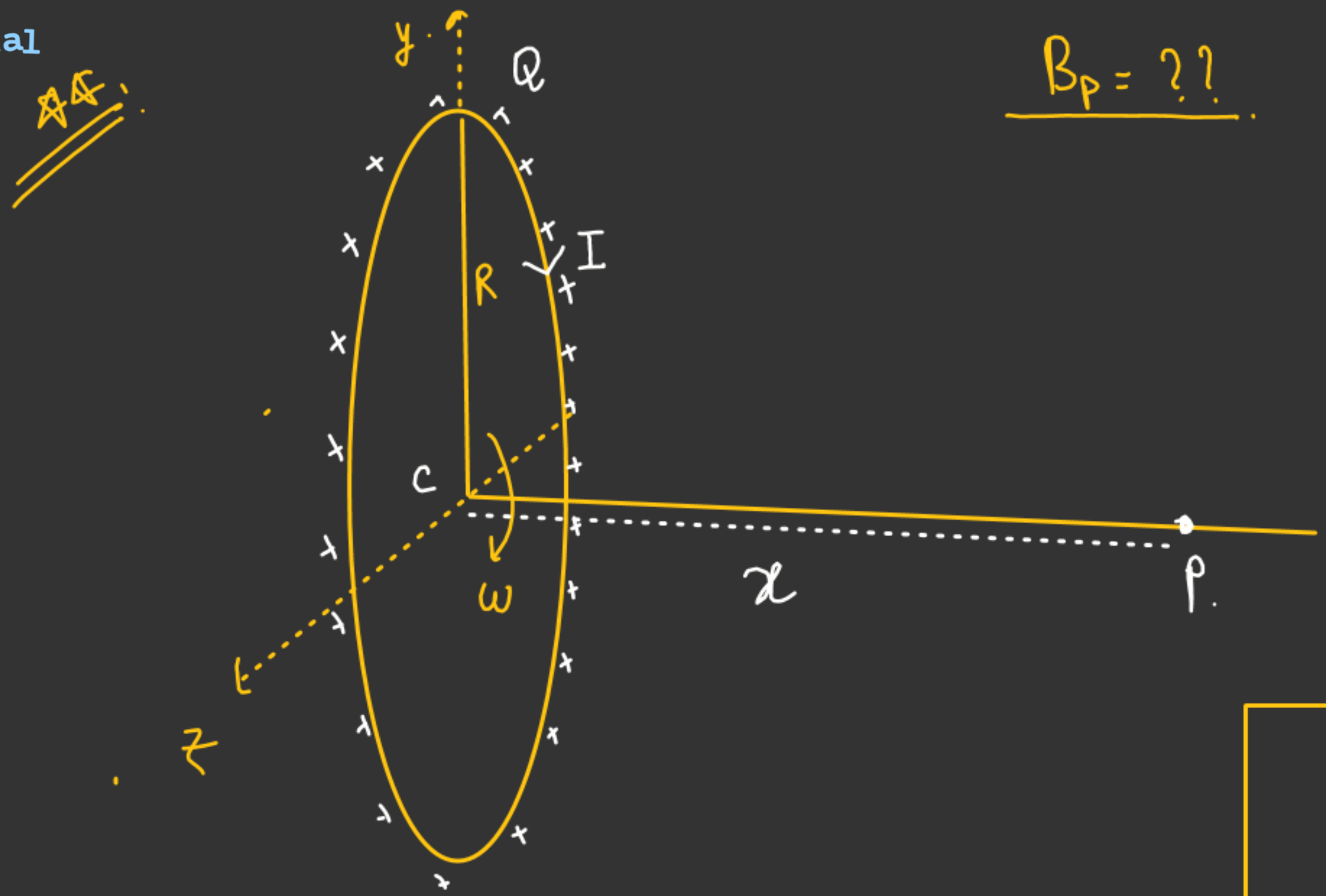

$B_P = ??$

$$I = \frac{Q}{T} = \left(\frac{Q\omega}{2\pi}\right)$$

$$B_P = \frac{\mu_0 I R^2}{2(x^2+R^2)^{3/2}}$$

$$B_P = \frac{\mu_0 R^2}{2(x^2+R^2)^{3/2}}\left(\frac{Q\omega}{2\pi}\right)$$

$$\boxed{B_P = \frac{\mu_0 Q\omega R^2}{4\pi (x^2+R^2)^{3/2}}}$$

At Center $x = 0$

$$B_C = \left(\frac{\mu_0 Q\omega}{4\pi R}\right)$$

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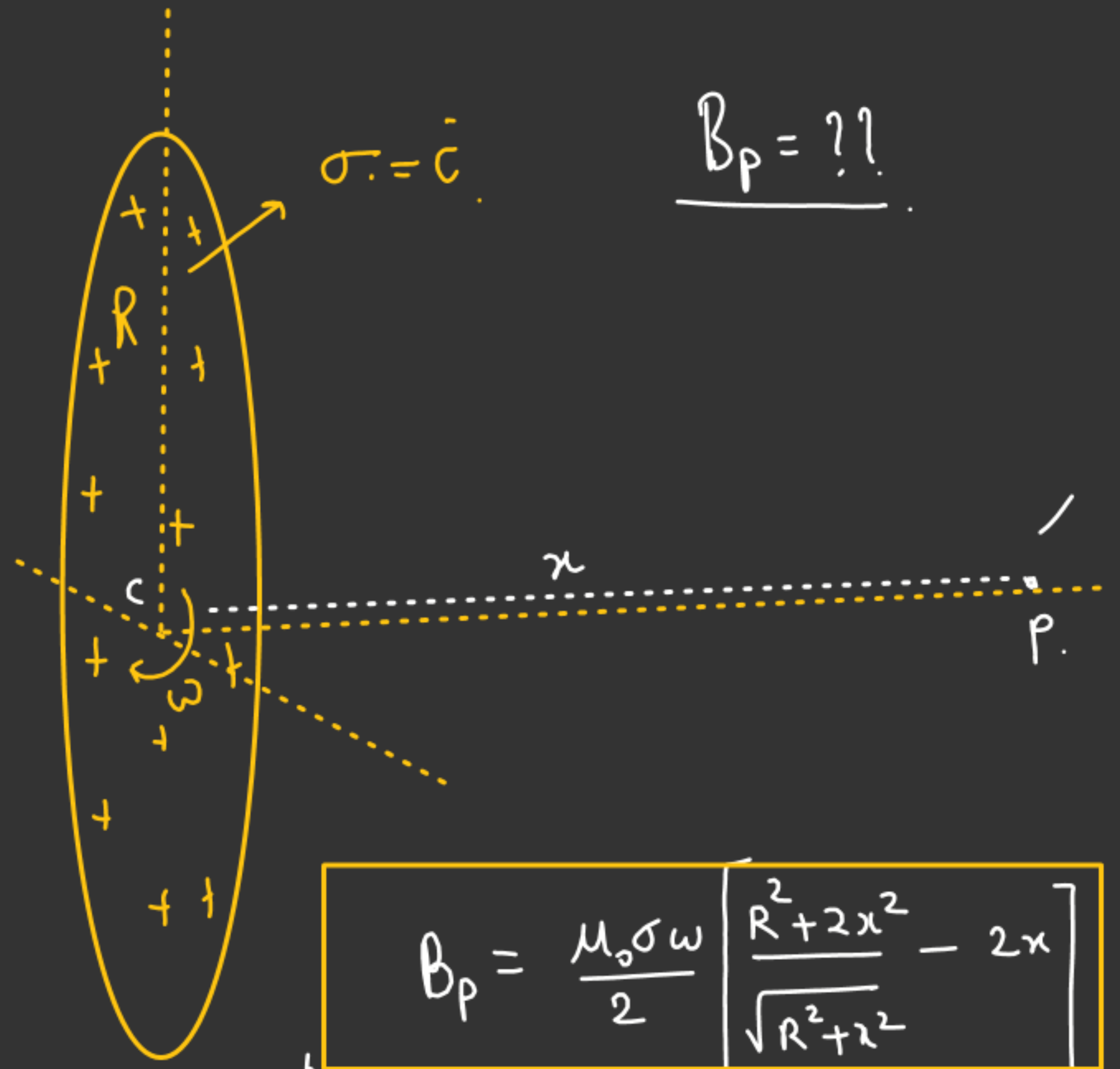
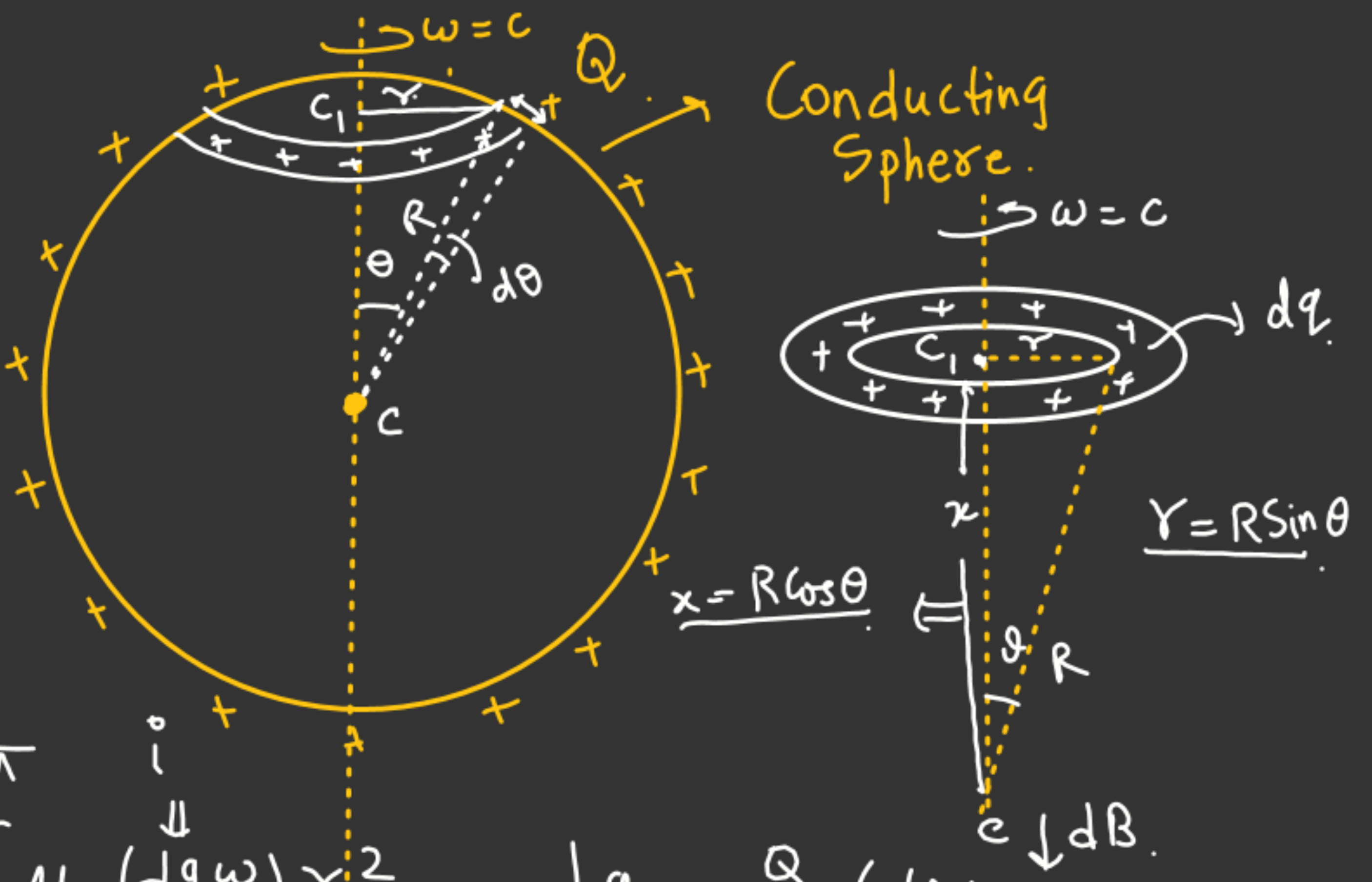


$B_p = ??$

$$\boxed{B_p = \frac{\mu_0 \sigma \omega}{2}\left[\frac{R^2+2x^2}{\sqrt{R^2+x^2}} - 2x\right]}$$

At Center, $x=0$

$$\boxed{B_c = \frac{\mu_0 \sigma \omega R}{2}}$$



$$\int_0^B dB = \int_0^{\pi} \frac{\mu_0 \left(\frac{dq\,\omega}{2\pi}\right) r^2}{2\,(r^2+x^2)^{3/2}}$$

$$\Downarrow$$

$$\boxed{B_c = \frac{2\mu_0 \omega \sigma R}{3}}$$

$$dq = \frac{Q}{4\pi R^2}(dA)$$

$$dq = \frac{Q}{4\pi R^2}\times(2\pi R\sin\theta)\,R\,d\theta$$

$$dq = \left(\frac{Q}{2}\sin\theta\, d\theta\right)$$