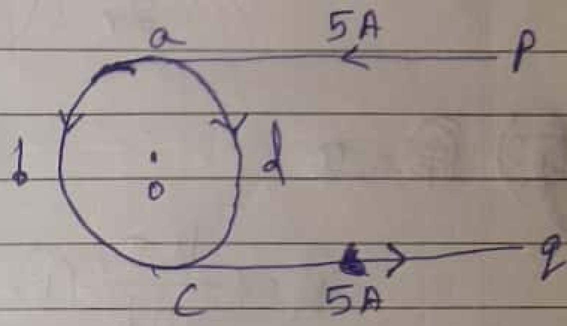
Dt-2/7/21

Home Assignment

1) diameter of coil = 10

$r = \frac{10}{2}$

$= 5cm.$



$I = 5A.$

~~There~~ $B_{pa} = \frac{\mu_0 I}{4\pi r}$

$= \frac{10^{-7} \times 5}{0.05}$

$= \frac{10^{-7} \times \cancel{5}}{\cancel{5} \times 10^{-2}}$

$= 10^{-5}\ T.$

Similarly, $B_{qc} = 10^{-5}\ T$ as it carries same current as B_{pa}.

So, $B_{net} = B_{pa} + B_{qc} = 10^{-5} + 10^{-5}$

$= 2 \times 10^{-5}\ T.$

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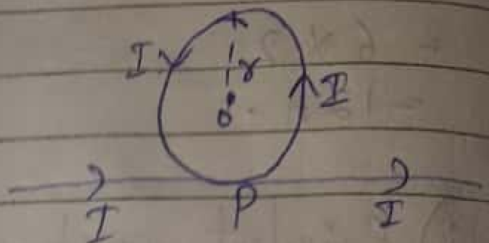
2) $B_{\text{straight wire}} = \frac{\mu_0 I}{2\pi r}$



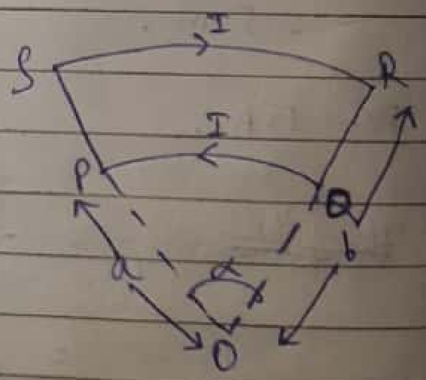
$B_{\text{circular current}} = \frac{\mu_0 I}{2r}$

$B_{\text{net}} = B_{\text{straight wire}} + B_{\text{circular current}}$

$= \frac{\mu_0 I}{2\pi r} + \frac{\mu_0 I}{2r}$

$= \frac{\mu_0 I}{2r}\left(\frac{1}{\pi} + 1\right)$ T.

3)



~~$B_1 = \frac{\mu_0 I}{4\pi b}(\theta)$~~

Magnetic due to an arc (B)

$= \frac{\mu_0 I}{4\pi r}(\theta)$.

So,

$\overset{\frown}{SR}$ $\otimes$ $B_1 = \frac{\mu_0 I}{4\pi b}(\alpha)$.

$\overset{\frown}{PQ}$ $\odot$ $B_2 = \frac{\mu_0 I}{4\pi a}(\alpha)$.

Then, $B_{\text{net}} = B_2 - B_1$

$= \frac{\mu_0 I}{4\pi a}(\alpha) - \frac{\mu_0 I}{4\pi b}(\alpha)$

$= \frac{\mu_0 I \alpha}{4\pi}\left(\frac{1}{a} - \frac{1}{b}\right)$

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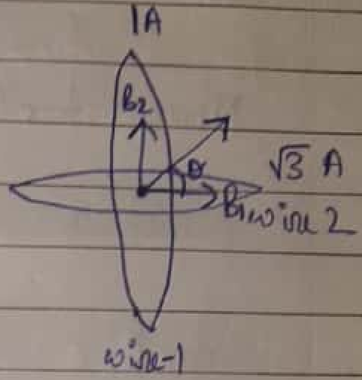
$$= \frac{\mu_0 I \alpha}{4\pi ab}(b-a) \cdot$$

4) $B_1 = \frac{\mu_0 I_1}{2R}$



$$= \frac{4\pi \times 10^{-7} \times 1}{2R}.$$

$\left[\frac{\mu_0}{4\pi} = 10^{-7} \quad \Rightarrow \mu_0 = 10^{-7} \times 4\pi\right]$

$$B_2 = \frac{\mu_0 I_2}{2R}$$

$$= \frac{4\pi \times 10^{-7} \times \sqrt{3}}{2R}.$$

Now, To get the net magnetic field, B_1 and B_2 will be vectorially added,

$$\vec{B}_{net} = \sqrt{B_1^2 + B_2^2 + B_1 B_2 \cos 90°}$$ [∵ As Both loops are perpendicular $\theta = 90°$]

$$= \sqrt{B_1^2 + B_2^2}$$

$$= \sqrt{\left(\frac{4\pi \times 10^{-7}}{2R}\right)^2 + \left(\frac{4\pi \times 10^{-7} \times \sqrt{3}}{2R}\right)^2}$$

$$= \frac{4\pi}{2R} \times 10^{-7}\left(\sqrt{3+1}\right)$$

$$= \frac{4\pi}{\cancel{2}R} \times 10^{-7} \times \cancel{2}$$

$$= \frac{4\pi \times 10^{-7}}{R}$$

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$= \frac{\mu_0}{R}$.

$\therefore$ The magnitude of the magnetic field is $\frac{\mu_0 R}{R}$.

Now, $\tan\theta = \frac{B_2}{B_1}$

$$= \frac{\frac{\cancel{4\pi \times 10^{-7}} \times \sqrt{3}}{\cancel{2R}}}{\frac{\cancel{4\pi \times 10^{-7}}}{\cancel{2R}}}$$

$= \sqrt{3}$.

As, $\tan 60^\circ = \sqrt{3}$

$\Rightarrow \theta = 60^\circ$.

$\therefore$ The direction of the net magnetic field is 60° from centre.

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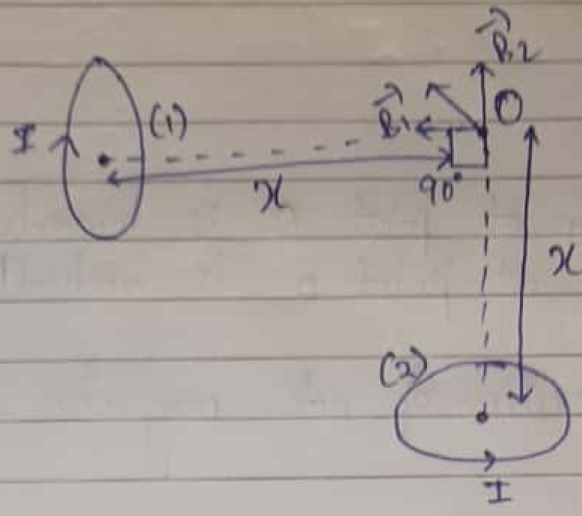
5)



Magnetic field due to current carrying circular loop is given by :-

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

So, magnetic field at point O due to loop 1 is,

$$B_1 = \frac{\mu_0 I R^2}{2(x^2+R^2)^{\frac{3}{2}}}$$

Similarly, magnetic field at point O due to loop 2 is,

$$B_2 = \frac{\mu_0 I R^2}{2(x^2+R^2)^{\frac{3}{2}}}.$$

So, $B_{net} = \sqrt{B_1^2 + B_2^2}$

$= \sqrt{2 B_1^2}$ [$\because$ As $B_1 = B_2$]

$= \sqrt{2}\, B_1$

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

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

Now,

As direction of B_1 at point O is towards left and the direction of B_2 at point O is vertically upwards,

~~Resultant direct~~ Direction of net magnetic field will be,

$$\tan\theta = \frac{B_2}{B_1}$$

$$= 1. \qquad [\because \text{As } B_1 = B_2].$$

So, $\tan 45^\circ = 1$

$\Rightarrow \theta = 45^\circ$.

$\therefore$ The direction of net magnetic field is at an angle of 45° from point O.

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