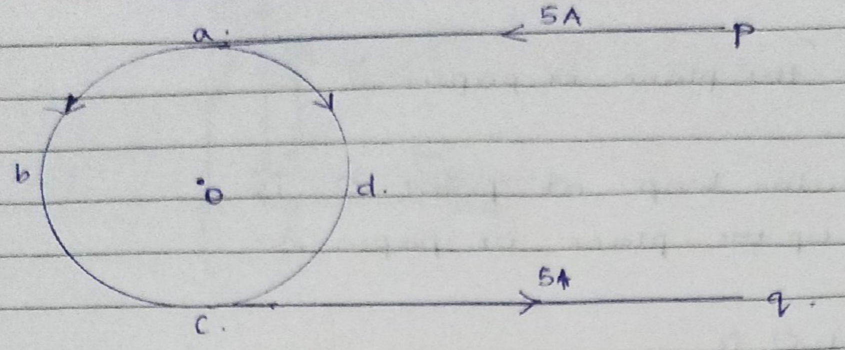
Home Assignment

1



Here $I_{abc} = I_{adc} = 2.5A$

$r = Oa = Ob = Oc = Od = 5cm = 5\times10^{-2}\,m$.

The magnetic induction at O due to the current in part abc of the coil is equal and opposite to the magnetic induction due to the current in ~~the~~ part adc. So magnetic induction at O due to the straight conductor pa (a half infinite segment) is

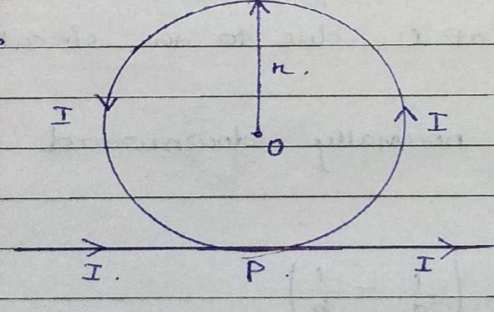
$$B_1 = \frac{1}{2}\frac{\mu_0 I}{2\pi r} = \frac{4\pi\times10^{-7}\times5}{4\pi\times5\times10^{-2}} = 10^{-5}\,T,$$ is normally out of the plane of paper.

Similarly, magnetic induction at O due to straight conductor qc is.

$$B_2 = \frac{\mu_0 I}{4\pi r} = 10^{-5}\,T,$$ normally out of the plane of paper.

Total magnetic induction at O is $B = B_1 + B_2 = 10^{-5} + 10^{-5} = 2\times10^{-5}\,T$ and is normally out of the plane of paper.

2.



The system consists of a straight conductor and a circular loop. Field due to straight conductor at point O is

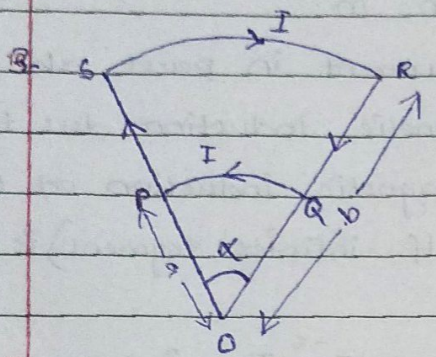
$B_1 = \frac{\mu_0 I}{2\pi r}$, up the plane of paper.

Field due to circular loop at point O is

$B_2 = \frac{\mu_0 I}{2r}$, up the plane of paper.

∴ Total field at O is

$$B = B_1 + B_2 = \frac{\mu_0 I}{2r}\left(1 + \frac{1}{\pi}\right)$$, up the plane of paper



Since the point O lies on lines SP and QR, so the magnetic field at O due to the straight portions is zero.

The magnetic field at O due to the circular segment PQ is

$$B_1 = \frac{\mu_0}{4\pi} \frac{I}{a^2} l \cdot \quad , l = \text{length of arc } PQ = \alpha a.$$

$$\therefore B_1 = \frac{\mu_0}{4\pi} \frac{I\alpha}{a}$$, directed normally upward.

Similarly, the magnetic field at O due to the circular segment SR is

$$B_2 = \frac{\mu_0}{4\pi} \cdot \frac{I\alpha}{b}$$, directed normally downward

The resultant field at O is

$$B = B_1 - B_2 = \frac{\mu_0 I\alpha}{4\pi}\left(\frac{1}{a} - \frac{1}{b}\right)$$

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

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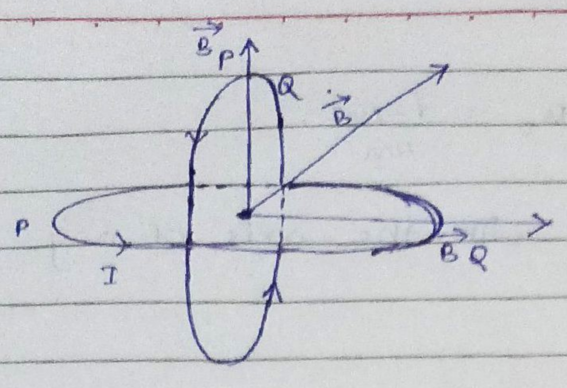
4.



$\vec{B_P} = \frac{\mu_0 I}{2R}$, vertically upwards.

$\vec{B_Q} = \frac{\mu_0 \sqrt{3}}{2R}$, along horizontal.

Resultant field at the centre is.

$$B = \sqrt{B_P^2 + B_Q^2}$$

$$= \left[\left(\frac{\mu_0 I}{2R}\right)^2 + \left(\frac{\mu_0 \sqrt{3}}{2R}\right)^2\right]^{1/2}$$

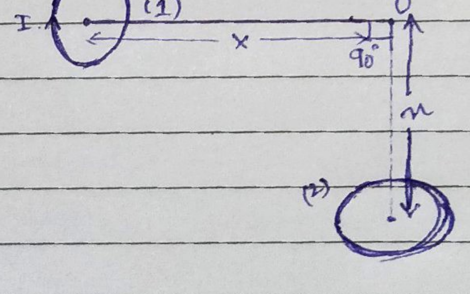
$$= \frac{\mu_0 I}{2R}(1+3)^{1/2}$$

$$= \frac{\mu_0}{2R}\sqrt{4}$$

$$= \frac{\mu_0 \cancel{2}}{\cancel{2}R}$$

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

5.



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

Net field at O,

$$B_0 = \sqrt{2}B = \frac{\sqrt{2}\,\mu_0 I r^2}{2(r^2+x^2)^{3/2}}$$

For small loop $(r << x)$, $B_0 = \frac{\sqrt{2}\mu_0 I}{2x^3}$.

The direction of B_0 is 45° with the axis of any of the two loops.