4th ~~July~~ July 2021

Homework (Physics)

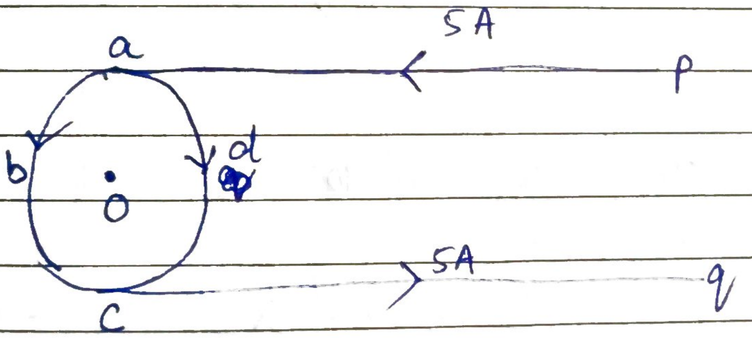
CHAPTER : MOVING CHARGES AND MAGNETISM

CHAPTER NO : 04

Concept of magnetic field on the axis of a circular current loop

Question 1

In figure abcd is a circular coil of the non insulated thin uniform conductor. Conductors pa and qc are very long straight parallel conductors tangential to the coil at the points a and c. If a current of 5A enters the coil from p to a, find the magnetic induction at O, the centre of the coil. The diameter of the coil is 10 cm.



The current in the part bcd of the coil is equal to the current in the part adc of the coil, which is equal to 2.5A

r = Oa = Ob = Oc = Od = 5 cm = Magnetic field induction at O due to current through circular coil will be zero because the magnetic field induction at O due to current through segment abc.

of the coil is equal and opposite to that due to current through segment bfd of the coil. Magnetic field induction at O due to current through long straight conductor ~~at is~~ pa is

$$B_1 = \frac{\mu_0}{4\pi} \frac{I}{r} (\sin 90^\circ + \sin 0^\circ)$$

$$\Rightarrow \frac{\mu_0}{4\pi} \frac{I}{r} = 10^{-7} \times \frac{5}{5 \times 10^{-2}} = 10^{-5} T$$

$$\cancel{\Rightarrow \frac{\mu_0}{4\pi} \frac{I}{r} = 10^{-7} \times}$$

outward normally to the plane of paper. Magnetic field induction at O due to current through long straight conductor cq.

is

$$B_2 = \frac{\mu_0}{4\pi} \frac{I}{r} (\sin 90^\circ + \sin 0^\circ)$$

$$= \frac{\mu_0}{4\pi} \frac{I}{r} = 10^{-7} \times \frac{5}{5 \times 10^{-2}} = 10^{-5} T$$

outwards normally to the plane of plane :-

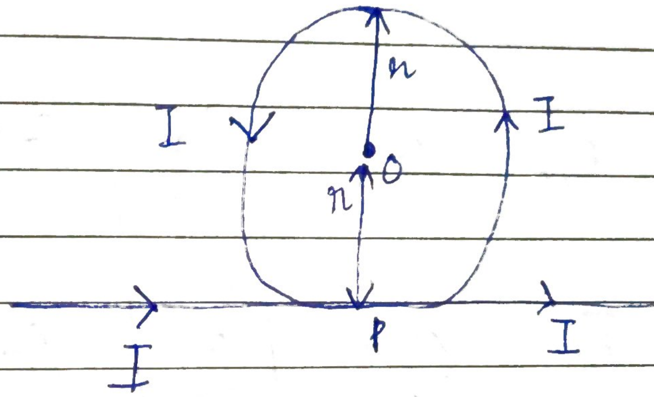
Total magnetic field induction at O :-

$$B = B_1 + B_2 = 10^{-5} + 10^{-5} = 2 \times 10^{-5} T$$

normal to plane of paper outwards.

Question 2

A long wire is bent as shown in the figure. What will be the ~~magneti~~ magnitude and direction of the field at the centre O of the circular portion if a current I is passed through the wire? Assume that the various portions of the wire do not touch at point P.



Ans.

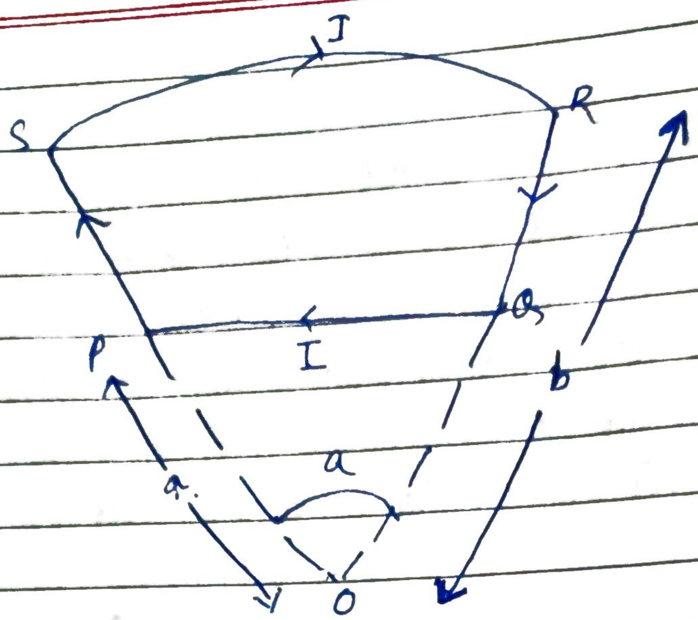
$$B_{st.\ line\ current} = \frac{\mu_0 I}{2\pi r} \odot$$

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

$$B_{net} = \left(\frac{\mu_0 I}{2\pi r} + \frac{\mu_0 I}{2r}\right) \odot$$

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

Ans 3



$$\vec{B}_{AB} = \frac{\mu_0 i}{2b}\left[\frac{\theta}{2\pi}\right](-k)$$

$$\vec{B}_{cd} = \frac{\mu_0 i}{2a}\left[\frac{\theta}{2\pi}\right](-k)$$

B_{Net}

B due to AD & BC will be zero.

$$\vec{B}_{Net} = \frac{\mu_0 i\theta}{4\pi}\left[\frac{1}{a} - \frac{1}{b}\right]$$

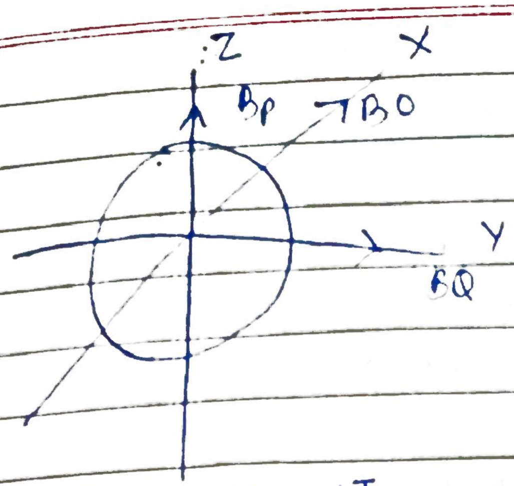
$$= \frac{\mu_0 i\theta}{4\pi ab}(b-a)$$

Ans 4 Radius = R

$I_p = 1A$

$I_q = \sqrt{3}\,A$

For coils in xy and yz planes being mutually perpendic



$$B_P = \frac{\mu_0 N I}{2R}$$

$$B_O = \frac{\mu_0 N I \sqrt{3}}{2R}$$

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

$$= \sqrt{\left(\frac{\mu_0 N I}{2R}\right)^2 + \left(\frac{\mu_0 N I \sqrt{3}}{2R}\right)^2}$$

$$= \frac{\mu_0 N I}{2R} \sqrt{1+3}$$

$$= \frac{\mu_0 N I}{R}$$

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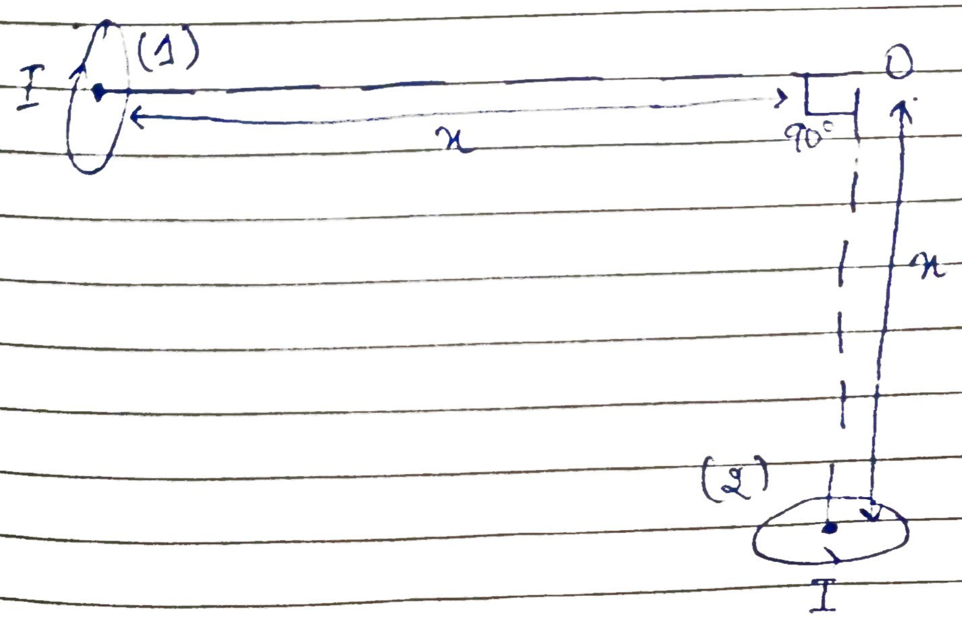

Ans// We know, Magnetic field due to circular loop =

$$\frac{\mu_0}{4\pi}\ \frac{2\pi R^2 I}{(x^2+R^2)^{3/2}}$$

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

$$|\vec{B}_{net}| = \sqrt{2}\,|\vec{B}| = \frac{\sqrt{2}\,\mu_0 R^2 \cdot I}{2(x^2+R^2)^{3/2}}$$

So net magnetic field magnetic ($|\vec{B}_{net}|$) and its direction is $\dfrac{\mu_0 R^2 I}{\sqrt{2}(x^2+R^2)^{3/2}}$

is along vector $\dfrac{-\hat{i}-\hat{j}}{\sqrt{2}}$

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