1 July 2021

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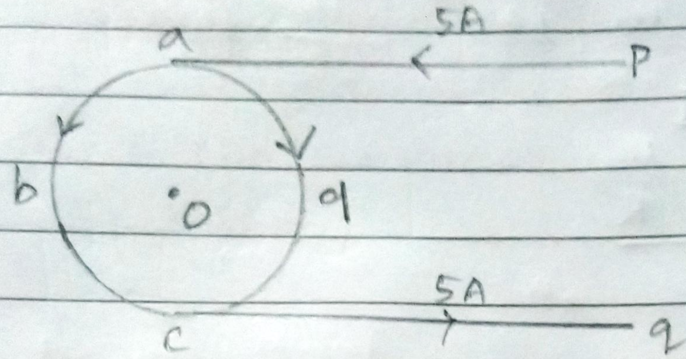
## Home Assignment

1)




Soln Magnetic field at point O due to the straight conductor PA is

$$B_1 = \frac{1}{2}\left[\frac{\mu_0 I}{2\pi r}\right]$$

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

Similarly, magnetic field at a point O due to straight conductor QC is

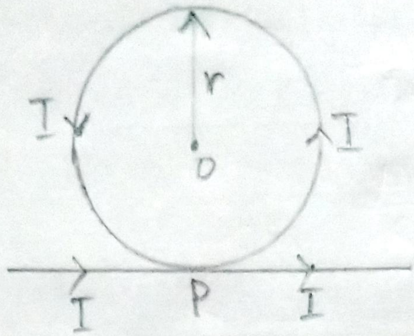
$$B_2 = \frac{\mu_0 I}{4\pi r} = 10^{-5}\,T$$

Both the magnetic fields $B_1$ & $B_2$ are acting normally out of the plane of paper, so the total magnetic field $\vec{B}$ is

$$B = B_1 + B_2$$

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

2)




Magnitude of the magnetic ~~field~~ field at O due to the straight part of the wire is

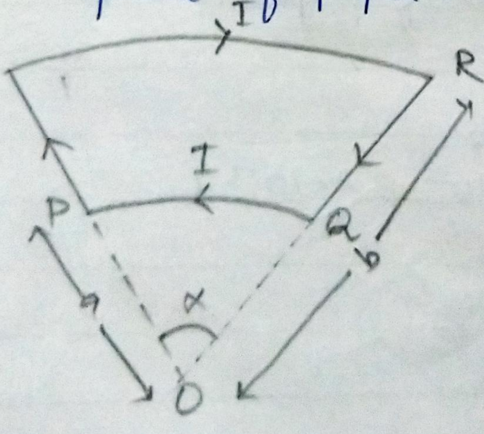
$B_1 = \frac{\mu_0}{2\pi} \cdot \frac{I}{R}$, normally out of the ~~pede~~ plane of paper magnetic field at the centre O due to the current loop of radius R is

$B_2 = \frac{\mu_0 I}{2R}$, normally in to the plane of paper

Resultant field at O is

$B = B_2 - B_1 = \frac{\mu_0 I}{2R}\left(1 - \frac{1}{\pi}\right)$, normally into the plane of paper.

3)



Magnetic field due to slide lines will be zero as they exist on same line.

Due to circular arc.

$$B = \frac{\mu_0 I \theta}{4\pi r}$$

Here for $r = a$

$$\vec{B_1} = \frac{\mu_0 I \theta}{4\pi a} \text{ (outside)}$$

For $r = b$

$$\vec{B_2} = \frac{\mu_0 I \theta}{4\pi b} \text{ (inside)}$$

Net magnetic field

$$B = B_1 - B_2$$

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

4) we know that, $B = \frac{\mu_0 I}{2R}$

$$B_1 = \frac{\mu_0}{2R} \cdot I$$

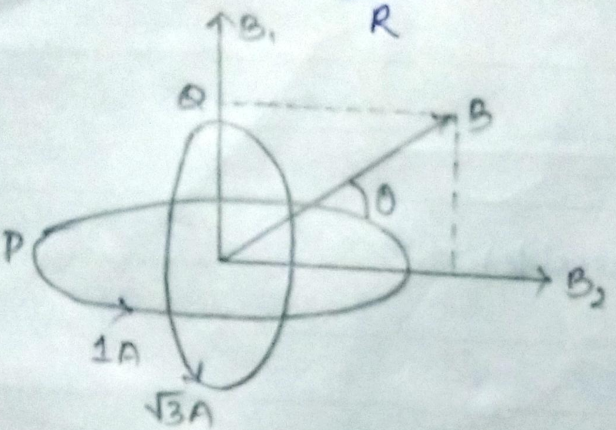
$$B_2 = \frac{\mu_0}{2R} \cdot \sqrt{3}$$

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

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

$$B = \frac{\mu_0}{2R}\sqrt{1+3} = \frac{\mu_0}{2R}\cdot\sqrt{4}$$

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



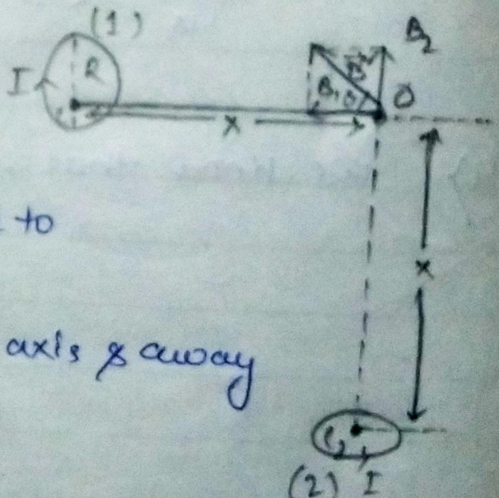

$$\tan\theta = \frac{B_1}{B_2} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \theta = 30^\circ.$$

5) Magnetic field at point O, due to circular loop (1)

$$B_1 = \frac{\mu_0 I a^2}{2(a^2+x^2)^{3/2}},$$ along the axis & towards the loop (1).

Where a is the radius of the circular loop.




Magnetic field at point O, due to circular loop (2)

$$B_2 = \frac{\mu_0 I a^2}{2(a^2+x^2)^{3/2}},$$ along the axis & away from the loop (2).

Net magnetic field at point O,

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$$B = \sqrt{B_1^2 + B_2^2 + 2B_1B_2\cos 90^\circ}$$

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

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

$$\tan\theta = \frac{B_2}{B_1} = 1$$

$$= \tan \pi/4$$

$$\theta = \pi/4$$

$\therefore$ Magnetic field at point o is directed at an angle $\pi/4$ with the direction of magnetic field $\vec{B_1}$.