4 July '2021

Home Assignment

1. 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 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 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 $r = a$

$$\vec{B}_1 = \frac{\mu_0 I \theta}{4\pi a} \quad (\text{outside})$$

For $r = b$

$$\vec{B}_2 = \frac{\mu_0 I \theta}{4\pi b} \quad (\text{inside})$$

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, $B = \dfrac{\mu_0 I}{2R}$

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

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

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

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

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

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

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

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

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

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

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

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

Resultant magnetic field at O will be

$$B = \sqrt{B_1^2 + B_1^2} \quad (\because B_1 = B_2)$$

$$= \sqrt{2} B_1$$

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

This resultant field acts at an angle of 45° with the axis of loop 1