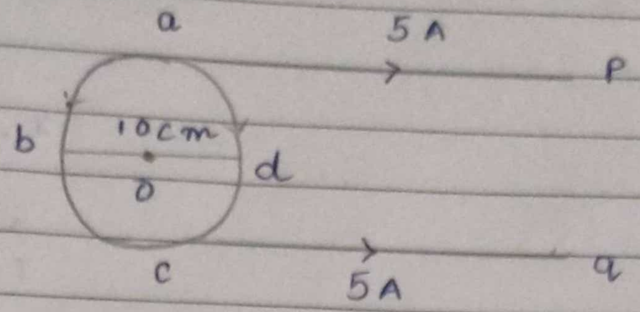
4/7/21

1.



$r = \frac{10}{2} = 5\ cm$

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

The magnetic induction at O due to the current in part abc is equal and opposite to the magnetic induction due to the part in adc.

Magnetic induction at Pa,

$B_1 = \frac{\mu_0 I l}{4\pi r^2} = \frac{4\pi \times 10^{-7} \times \cancel{5}}{\cancel{4\pi} \times \cancel{5} \times 10^{-2}}$

$= 10^{-5}\ T$

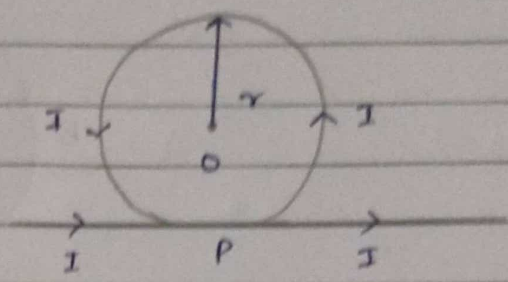
Magnetic induction at qc,

$B_2 = \frac{\mu_0 I l}{4\pi r^2} = \frac{4\pi \times 10^{-7} \times 5}{4\pi \times 5 \times 10^{-2}}$

$= 10^{-5}\ T$

Total magnetic induction $= B_1 + B_2$
$= 2 \times 10^{-5}\ T$

2.



$$\cancel{B = \frac{\mu_0 I}{2\pi r}}$$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

The magnetic induction in the direction due to straight line

$$B_1 = \frac{\mu_0 I}{2\pi r}$$

The magnetic induction in the direction due to a circular loop

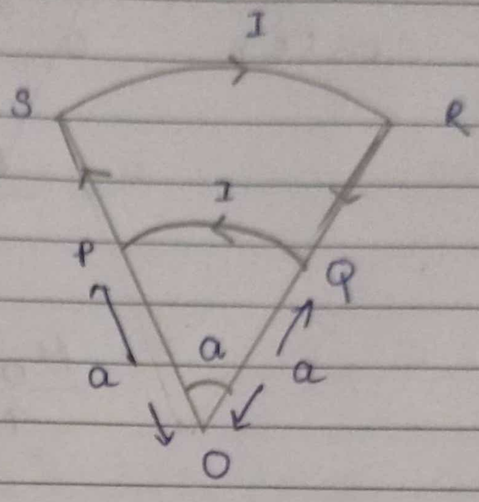
$$B_2 = \frac{\mu_0 I}{2\pi r}$$

Total magnetic induction $= B_1 + B_2$

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

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

3.



The magnetic induction along circular segment PQ ~~magnetic induction~~ :

$$B_1 = \frac{\mu_0 I}{4\pi a^2} l$$

$l = a$

B_1 is point vertically upwards

$$B_1 = \frac{\mu_0 I a}{4\pi a}$$

B_2 is pointing vertically downwards

$\downarrow$

The ~~circular segment~~ SR. magnetic field along the circular segment SR:

$$B_2 = \frac{\mu_0 I a}{4\pi b}$$

~~Total magnetic field at the center O = $B_1 \pm B_2$~~

~~$$= \frac{\mu_0 I a}{4\pi a} \pm \frac{\mu_0 I a}{4\pi b}$$~~

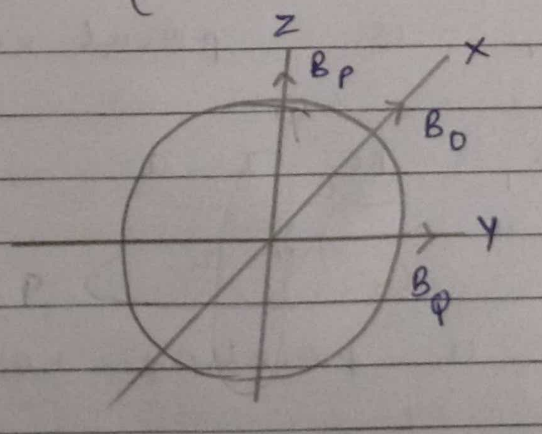
~~$$= \frac{\mu_0 I a}{4\pi}\left(\frac{1}{a} \pm \frac{1}{b}\right)$$~~

Total magnetic field at the center O, $B = B_1 - B_2$

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

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

4.



$$B_P = \frac{\mu_0 I}{2R}, \quad B_Q = \frac{\mu_0 I}{2R}$$

$$B_P = \frac{\mu_0 N \times 1 \times I}{2R} \quad , \quad B_Q = \frac{\mu_0 N \times \sqrt{3} \times I}{2R}$$

$$\vec{B}_P = \frac{\mu_0 N \times 1 \times I}{2R}, \text{ vertically upwards}$$

$$\vec{B}_Q = \frac{\mu_0 N \times \sqrt{3} I}{2R}, \text{ along horizontal.}$$

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

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

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

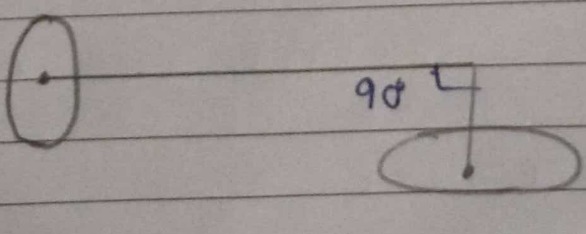
$$= \frac{\mu_0 NI}{R}$$

$$\tan\theta = \frac{B_P}{B_Q}$$

$$= \frac{1}{\sqrt{3}}$$

$$= 30^\circ$$

5.



Magnetic field due to circular loop

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

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

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

So net magnetic field magnetic ($|\vec{B}_{net}|$) and its direction is

$$\frac{\mu_0 R^2 I}{\sqrt{2}(x^2+R^2)^{3/2}}$$ is along vector $\frac{-\hat{i}-\hat{j}}{\sqrt{2}}$.