

Two concentric circular coils X and Y of radii 16 cm and 10 cm, respectively, lie in the same vertical plane containing the north to south direction. Coil X has 20 turns and carries a current of 16 A; coil Y has 25 turns and carries a current of 18 A. The sense of the current in X is anticlockwise, and clockwise in Y, for an observer looking at the coils facing west. Give the magnitude and direction of the net magnetic field due to the coils at their centre.

Radius of coil X, $r_1 = 16 \text{ cm} = 0.16 \text{ m}$

Radius of coil Y, $r_2 = 10 \text{ cm} = 0.1 \text{ m}$

Number of turns of on coil X, $n_1 = 20$

Number of turns of on coil Y, $n_2 = 25$

Current in coil X, $I_1 = 16 \text{ A}$

Current in coil Y, $I_2 = 18 \text{ A}$

Magnetic field due to coil X at their centre is given by the relation,

$$B_1 = \frac{\mu_0 N_1 I_1}{2r_1}$$

Where, $\mu_0 =$ Permeability of free space $= 4\pi \times 10^{-7} \text{ T m A}^{-1}$

$$B_1 = \frac{4\pi \times 10^{-7} \times 20 \times 16}{2 \times 0.16} = 4\pi \times 10^{-4} \text{ T (Towards East)}$$

Magnetic field due to coil Y at their centre is given by the relation,

$$B_2 = \frac{\mu_0 N_2 I_2}{2r_2}$$

Where, $\mu_0 =$ Permeability of free space $= 4\pi \times 10^{-7} \text{ T m A}^{-1}$

$$B_2 = \frac{4\pi \times 10^{-7} \times 25 \times 18}{2 \times 0.10} = 9\pi \times 10^{-4} \text{ T (Towards West)}$$

Hence, net magnetic field can be obtained as:

$$B = B_2 - B_1 = 9\pi \times 10^{-4} \text{ T} - 4\pi \times 10^{-4} \text{ T}$$

$$= 5\pi \times 10^{-4} \text{ T}$$

$$= 5 \times 3.14 \times 10^{-4} \text{ T} = 1.57 \times 10^{-3} \text{ T (Towards West)}$$