

5. Fig. 2 shows a long wire XY carrying a current of 30A. The rectangular loop ABCD carries a current of 20A.

(a) Calculate the magnetic field due to XY along

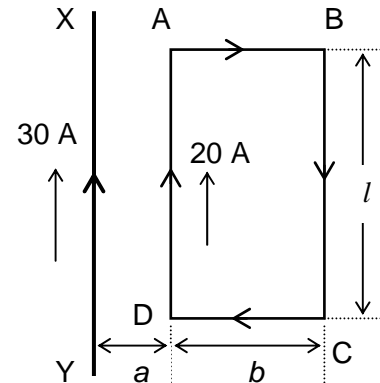
(i) AD

(ii) BC

(The flux density at a perpendicular distance r from a very long straight wire carrying a current I is given by $B = \mu_0 I / 2\pi r$.)

(b) Hence calculate the resultant force acting on the loop.

Take $a = 1.0$ cm, $b = 8.0$ cm and $l = 30$ cm.



Solution

$$\text{(a)(i)} \quad B_{AD} = \mu_0 I_{xy} / 2\pi a$$

$$= (4\pi \times 10^{-7})(30) / 2\pi(0.010)$$

$$= 6.0 \times 10^{-4} \text{ T} //$$

$$\text{(ii)} \quad B_{BC} = \mu_0 I_{xy} / 2\pi(b+a)$$

$$= (4\pi \times 10^{-7})(30) / 2\pi(0.010 + 0.080)$$

$$= 6.7 \times 10^{-5} \text{ T} //$$

$$\text{(b)} \quad \text{Resultant force acting on the loop} = F_{AB} - F_{BC}$$

(taking left as +ve)

$$= B_{AD} I_{AD} l - B_{BC} I_{BC} l$$

$$= (6.0 \times 10^{-4} - 6.7 \times 10^{-5})(20)(0.30)$$

$$= 3.2 \times 10^{-3} \text{ N (to the left)} //$$