$= I l B_2 a_y$

Two current flow in same direction → attractive force

$\therefore F_1 = l I_1 \frac{\mu I_2}{2\pi D} a_y$

Opposite direction → repulsive force

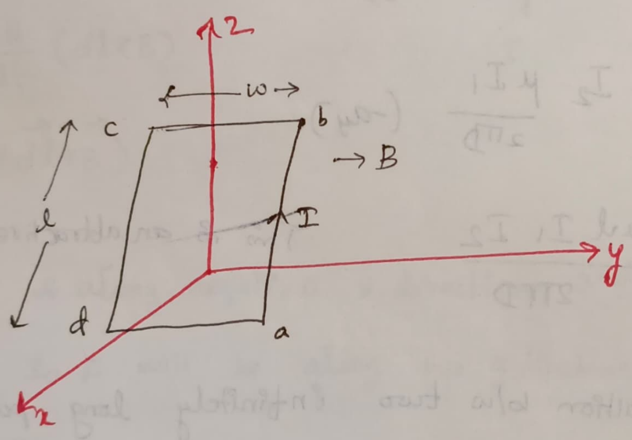
$|F_1| = \frac{\mu I_1 I_2 l}{2\pi D}$

F is along +ve y direction. This is also an attractive force

$|F_1| = |F_2|$

Torque on a loop carrying current I

force that tends to cause rotation (rotation force / twisting force)



Force = BIl (on the sides ab & cd)

Force = 0 (on the sides da & bc) since I & B are parallel to each other.

Torque is the tangential force multiplied by the radial distance at which the force acts.

Total torque on the loop abcd

= 2 × Torque on each side

= 2 × Force × Distance from axis of rotation

$= 2 \times BIl \times w/2$

vector form :-

$\vec{T} = \vec{m} \times \vec{B}$ N/m

$T = BIlw$

$T = BIA$.

If there are N turns then torque

$T = NBIA$.

Note:

1) If B is at an angle of θ with the axis of rotation then the tangential component of force is given by

$F_t = F \cos\theta$

$\therefore T = BIA \cos\theta$

2) If B is perpendicular to plane of the loop then $\theta = 90°$

$T = 0$

Torque is a function of position of coil.

$T = BM \cos\theta$

where $M = IA$ → magnetic dipole moment.

3) If $\theta = 0$

then $T = BM$

$M = \frac{T}{B}$

Thus magnetic moment is defined as maximum torque on the loop per unit magnetic induction.

$\cos\theta = \frac{F_t}{F}$