Assignment - 02

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Answer to the Q. NO - 01

We know,

magnetic force, $\vec{F}_B = q\vec{v} \times \vec{B}$

$= q(\vec{v} \times \vec{B})$

from this equation,

we can write with vector notation,

$\vec{F} = q(v_x B_y - v_y B_x)\hat{k}$

$= q(V_x(3B_x) - v_y B_x)\hat{k}$

$B_y = 3B_x$

$V_x = 2.0\ m/s$

$V_y = 4.0\ m/s$

$q = -1.6 \times 10^{-19}\ C$

As Force $(\vec{F})$ (considered at an instant point) is,

$F_z = 6.4 \times 10^{-19}\ N.$

$\therefore q(3V_x - V_y)B_x = F_z$

$\Rightarrow B_x = \dfrac{F_z}{q(3V_x - V_y)}$

$\Rightarrow B_x = \dfrac{6.4 \times 10^{-19}\ N}{(-1.6 \times 10^{-19}\ C)\{3(2.0\ m/s) - 4.0\ m\}}$

$\therefore B_x = -2.0\ T$

(Ans:)

Answer to the Q. NO - 02

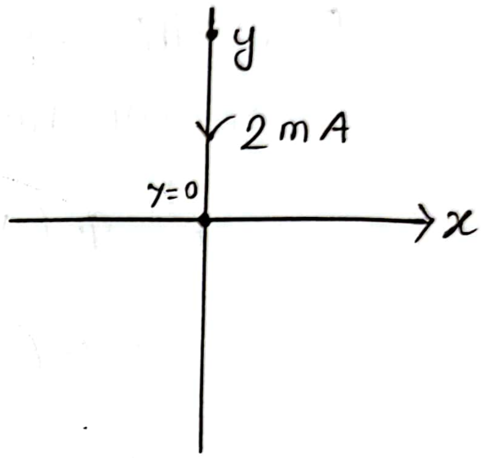
We know,

The force acting on a current element in a magnetic field is,

$$d\vec{F} = i d\vec{L} \times \vec{B} \quad \text{— ①}$$

Here,

the vector associated with the current element $(d\vec{L})$ is $= -\hat{j}$.



∴ The force on this current element is,

$$d\vec{F} = i d\vec{L} \times (-\hat{j}) \times 3y\hat{i} + 0.4y\hat{j}$$

Now,

$$d\vec{F} = 0.3\, iy\, d\vec{L}\, \hat{K} \qquad \left[\because \hat{j} \times \hat{i} = -\hat{K},\ \hat{j} \times \hat{j} = 0\right]$$

$$= 6.00 \times 10^{-4}\ N/m^2)\, y\, d\vec{L}\, \hat{K}$$

$$\therefore \vec{F} = \int d\vec{F} = \hat{K} \int_0^{0.25} y \cdot dy =$$

$y = 0$ to $0.250\ m$

$i = 2.00\ mA$

$\vec{B} = (0.300\ T/m) y\hat{i} + (0.400\ T/m\ y\hat{j})$

$$= \hat{K} \left(\frac{(0.25)^2}{2} \right) = 6.00 \times 10^{-4} \times \left(\frac{(0.25)^2}{2} \right)$$

$$= (1.88 \times 10^{-5}\ N)\, \hat{K}$$

(Ans:)

Answer to the Question NO - 3 (a)

We know,

Torque acting on a loop,

$$\vec{\tau} = \vec{\mu} \times \vec{B}$$

given,

The magnetic dipole moment,

$$\vec{\mu} = \mu(0.60\hat{i} - 0.80\hat{j})$$

Here,

uniform magnetic field,

$$\vec{B} = (0.25T)\hat{i} + (0.30T)\hat{k}$$

$$i = 0.20A$$

$$r = 0.080 \text{ m}$$

Now,

$$\mu = NiA$$

$$= Ni\pi r^2$$

$$= 1 \times (0.20) \times 3.1416 \times (0.080)^2$$

$$= 4.02 \times 10^{-4} \text{ Am}^2$$

$\therefore$ Torque, $\vec{\tau} = \vec{\mu} \times \vec{B}$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0.0024 & -0.0032 & 0.0 \\ 0.25 & 0.0 & 0.30 \end{vmatrix}$$

$$= \hat{i}(-0.0032 \times 0.3) - \hat{j}(0.0024 \times 0.3) + \hat{k}(0.0032 \times 0.25)$$

$$= (-9.6\hat{i} - 7.2\hat{j} + 8.0\hat{k}) \times 10^{-4} \text{ Nm}$$

(Ans:)

Answer to the Question NO – 3(b)

The orientation energy of the loop (dipole),

$$U = -\vec{\mu} \cdot \vec{B}$$

$$= -\mu\left(0.60\hat{i} - 0.80\hat{j}\right) \cdot \left(0.25\hat{i} + 0.30\hat{k}\right)$$

$$= -\mu\,(0.60) \times (0.25)$$

$$= -0.15\,\mu$$

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

Here,

$\hat{i} \cdot \hat{i} = 1$

$\hat{i} \cdot \hat{k} = 0$

$\hat{j} \cdot \hat{i} = 0$

$\hat{j} \cdot \hat{k} = 0$

(Answer)