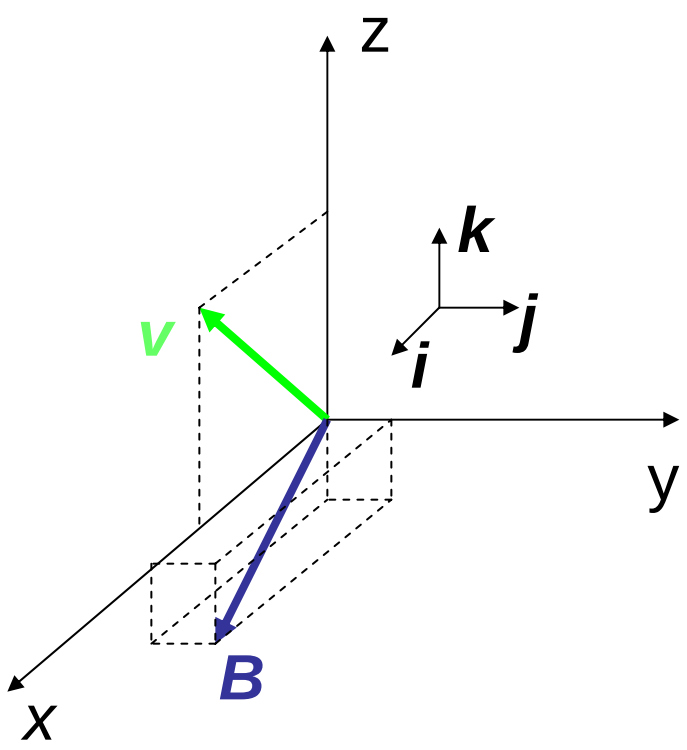
Review for Quiz 7



A proton with a velocity

$\boldsymbol{v} = (2.5\ 10^6\ \text{m/s})\boldsymbol{i} + (2.5\ 10^6\ \text{m/s})\boldsymbol{k}$

Moves through the magnetic field

$\boldsymbol{B} = (0.5\ \text{T})\boldsymbol{i} + (0.05\ \text{T})\boldsymbol{j} - (0.05\ \text{T})\boldsymbol{k}$

Find the force on the proton

($e = 1.6\ 10^{-19}$ C)

Represent your answer as:

$\boldsymbol{F}_B = (?)\ \boldsymbol{i} + (?)\ \boldsymbol{j} + (?)\ \boldsymbol{k}$

$$\boxed{v_y = 0}$$

$$\overline{F}_B = q\left[\overline{v} \times \overline{B}\right]$$

$$\left[\overline{v} \times \overline{B}\right] = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ v_x & v_y & v_z \\ B_x & B_y & B_z \end{vmatrix} =$$

$$\bar{i}\begin{vmatrix} v_y & v_z \\ B_y & B_z \end{vmatrix} - \bar{j}\begin{vmatrix} v_x & v_z \\ B_x & B_z \end{vmatrix} + \bar{k}\begin{vmatrix} v_x & v_y \\ B_x & B_y \end{vmatrix} =$$

$$= \bar{i}\left(\cancel{v_y B_z} - v_z B_y\right) - \bar{j}\left(v_x \cdot B_z - v_z \cdot B_x\right) + \bar{k}\left(v_x B_y - \cancel{v_y B_x}\right) =$$

$$= -\bar{i} \cdot v_z \cdot B_y - \bar{j}\left(v_x \cdot B_z - v_z \cdot B_x\right) + \bar{k} \cdot v_x \cdot B_y =$$

Substituting components:

$$v_z \cdot B_y = 2.5 \cdot \omega^{6} \cdot 5 \cdot \omega^{-2} = 12.5 \cdot \omega^{4} = \underline{1.25 \cdot \omega^{5}}$$

$$(v_x B_z - v_z \cdot B_x) = 2.5 \cdot \omega^{6} (-5 \cdot \omega^{-2}) - 2.5 \cdot \omega^{6} \cdot 0.5 =$$

$$= -12.5 \cdot \omega^{4} - \underbrace{1.25 \cdot \omega^{6}}_{125 \cdot 10^{4}} = -137.5 \cdot \omega^{4} = \underline{-13.75 \cdot 10^{5}}$$

$$v_x \cdot B_y = 2.5 \cdot \omega^{6} \cdot 5 \cdot \omega^{-2} = 12.5 \cdot \omega^{4} = \underline{1.25 \cdot \omega^{5}}$$

$$\overline{F_B} = 1.6 \cdot \omega^{-19} \left[\left(-1.25 \cdot \omega^{5}\right) \cdot \bar{i} + \left(13.75 \cdot 10^{5}\right) \cdot \bar{j} + \left(1.25 \cdot \omega^{5}\right) \bar{k} \right] = \underline{\left(-2 \cdot 10^{-14} \cdot N\right) \cdot \bar{i} + \left(17.2 \cdot 10^{-14} \cdot N\right) \cdot \bar{j} + \left(2 \cdot 10^{-14} \cdot N\right) \cdot \bar{k}}$$