Problem 5.1

An electron with a speed of 8×10^6 m/s is projected along the positive x direction into a medium containing a uniform magnetic flux density $\mathbf{B} = (\hat{\mathbf{x}}4 - \hat{\mathbf{z}}3)T$

Given that e = $1.6*10^{19}$ C and the mass of an electron is me = $9.1*10^{-31}$ kg, determine the initial acceleration vector of the electron (at the moment it is projected into the medium).

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Known Values:

$$Electron\ speed: u = 8 * 10^6 \frac{m}{s}$$

$$Magnetic\ Flux\ Density: \mathbf{B} = (\hat{\boldsymbol{x}}4 - \hat{\mathbf{z}}3)T$$

$$Elementary\ Charge: e = 1.6 * 10^{19}\ C$$

$$Electron\ Mass: m_e = 9.1 * 10^{-31}\ kg$$

Problem 5.1

Particle of a charge *q* moving with velocity **u** in a magnetic field experiences magnetic force $\mathbf{F}_m$ given by:

$Electron\ speed: u = 8 * 10^6 \frac{m}{s}$

$Magnetic\ Flux\ Density: \mathbf{B} = (\hat{\boldsymbol{x}}4 - \hat{\boldsymbol{z}}3)T$

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$$\mathbf{F}_\mathrm{m} = q\mathbf{u} \times \mathbf{B} \qquad (\mathrm{N})$$

Use Newton's Second Law: F = m * a

Rearrange equation and substitute **F** for equation above.

Problem 5.1

$$\boldsymbol{a} = \frac{\mathbf{F}_m}{m_e} = \frac{q\mathbf{u} \times \mathbf{B}}{m_e}$$

Assuming q = -e

$$= \frac{-1.6 * 10^{-19}}{9.1 * 10^{-31}} (\hat{\boldsymbol{x}}8 * 10^6) \times (\hat{\boldsymbol{x}}4 - \hat{\mathbf{z}}3)$$

$$= -\hat{\boldsymbol{y}}4.22 * 10^{18} \quad (m/s^2)$$

$Electron\ speed: u = 8 * 10^6 \frac{m}{s}$

$Magnetic\ Flux\ Density: \mathbf{B} = (\hat{\boldsymbol{x}}4 - \hat{\mathbf{z}}3)T$

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$$\overline{a} \times \overline{b} = \begin{vmatrix} \boldsymbol{i} & \boldsymbol{j} & \boldsymbol{k} \\ a_x & a_y & a_z \\ b_x & b_y & b_z \end{vmatrix} = \begin{vmatrix} \boldsymbol{i} & \boldsymbol{j} & \boldsymbol{k} \\ 8000000 & 0 & 0 \\ 4 & 0 & -3 \end{vmatrix} = \boldsymbol{i}(0\cdot(-3) - 0\cdot 0) - \boldsymbol{j}(8000000\cdot(-3) - 0\cdot 4) + \boldsymbol{k}(8000000\cdot 0 - 0\cdot 4) =$$

$$= \boldsymbol{i}(0 - 0) - \boldsymbol{j}(-24000000 - 0) + \boldsymbol{k}(0 - 0) = \{0; 24000000; 0\}$$