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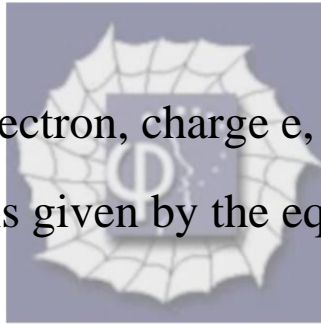
**Problem 34.7 (RHK)**

An electron in a uniform magnetic field has a velocity  $\vec{v} = (40\hat{i} + 35\hat{j}) \text{ km s}^{-1}$ . It experiences a force  $\vec{F} = (-4.2\hat{i} + 4.8\hat{j}) \text{ fN}$ . If  $B_x = 0$ , we have to calculate the magnetic field.

**Solution:**

The force on an electron, charge  $e$ , velocity  $\vec{v}$ , in magnetic field  $\vec{B}$  is given by the equation

$$\vec{F} = e\vec{v} \times \vec{B}.$$



Data of the problem are

$$\vec{v} = (40\hat{i} + 35\hat{j}) \text{ km s}^{-1},$$

$$\vec{F} = (-4.2\hat{i} + 4.8\hat{j}) \text{ fN} = (-4.2\hat{i} + 4.8\hat{j}) \times 10^{-15} \text{ N}.$$

As  $B_x = 0$ , we will write the magnetic field as

$$\vec{B} = (B_y\hat{j} + B_z\hat{k}).$$

We thus have the vector equation

$$(-4.2\hat{i} + 4.8\hat{j}) \times 10^{-15} \text{ N} = e(40\hat{i} + 35\hat{j}) \text{ km s}^{-1} \times (B_y\hat{j} + B_z\hat{k}). \quad (\text{A})$$

We will use the properties of the cross- product

$$\hat{i} \times \hat{j} = \hat{k}; \hat{j} \times \hat{k} = \hat{i}; \hat{k} \times \hat{i} = \hat{j};$$

and

$$\hat{a} \times \hat{b} = -\hat{b} \times \hat{a}; \text{ and } \hat{a} \times \hat{a} = 0,$$

and rewrite equation (A) as

$$(-4.2\hat{i} + 4.8\hat{j}) \times 10^{-15} \text{ N} = (40B_y\hat{k} - 40B_z\hat{j} + 35\hat{i}B_z) e \text{ km s}^{-1}.$$

$$\therefore B_y = 0,$$

and

$$B_z = \frac{4.2 \times 10^{-15}}{1.6 \times 10^{-19} \times 35} \times \frac{\text{N}}{\text{C km s}^{-1}} = 7.5 \times 10^2 \text{ T}.$$

It may be noted that the  $\hat{j}$ -equation is consistent with the  $\hat{i}$ -equation, as it also gives

$$B_z = \frac{4.8 \times 10^{-15}}{1.6 \times 40 \times 10^{-19}} \times \frac{\text{N}}{\text{C km s}^{-1}} = 7.5 \times 10^2 \text{ T}.$$

Therefore, the magnetic field is

$$\hat{B} = 0.75\hat{k} \text{ kT}.$$



