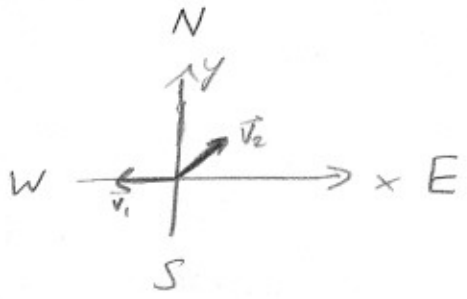
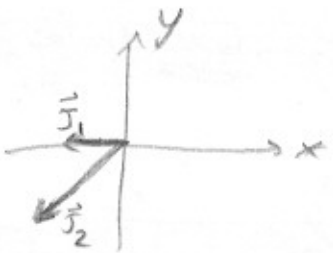
4.1

$$\begin{cases} n_1 = 5\times10^{10} \text{ ions/cm}^3 \\ q_1 = 2e \\ \vec{V}_1 = (10^7 \text{ cm/s})(-\hat{x}) \\ n_2 = 10^{11} \text{ electrons/cm}^3 \\ q_2 = -e = -4.803\times10^{-10} \text{ esu} \\ \vec{V}_2 = (10^8 \text{ cm/s})\left(\frac{\hat{x}+\hat{y}}{\sqrt{2}}\right) \end{cases}$$



(These diagrams are not to scale.)



Eq 3 on page 125:

$$\vec{J} = n_1 q_1 \vec{V}_1 + n_2 q_2 \vec{V}_2$$

$$\vec{J} = (5\times10^{10}\text{ cm}^{-3})(2\cdot4.803\times10^{-10}\text{ esu})(-10^7\,\hat{x}\text{ cm/s}) + (10^{11}\text{ cm}^{-3})(-4.803\times10^{-10}\text{ esu})\left(\frac{10^8(\hat{x}+\hat{y})\text{ cm/s}}{\sqrt{2}}\right)$$

$$\vec{J} = -4.803\times10^{8}\,\hat{x}\text{ esu cm}^{-2}\text{ s}^{-1} - 3.396\times10^{9}(\hat{x}+\hat{y})\text{ esu/cm}^2\text{s}$$

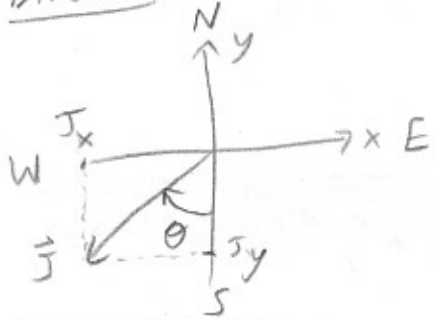
$$\vec{J} = -3.877\times10^{9}\,\hat{x}\text{ esu/cm}^2\text{s} - 3.396\times10^{9}\,\hat{y}\text{ esu/cm}^2\text{s}$$

Magnitude:

$$|\vec{J}| = \sqrt{J_x^2 + J_y^2} = \boxed{5.15\times10^{9}\text{ esu/cm}^2\text{s}}.$$

$$|\vec{J}| = 5.15\times10^{9}\frac{\text{esu}}{\text{cm}^2\text{s}}\cdot\left(\frac{1\text{ amp}}{3\times10^{9}\text{ esu/s}}\right)\cdot\left(\frac{100\text{ cm}}{1\text{ m}}\right)^2 = \boxed{1.72\times10^{4}\text{ amp/m}^2}.$$

Direction:



$$\theta = \arctan\left(\frac{J_x}{J_y}\right) = \underline{48.8^\circ}$$

$\vec{J}$ points in the direction 48.8° west of south.

$$\tan\theta = \frac{J_x}{J_y}.$$