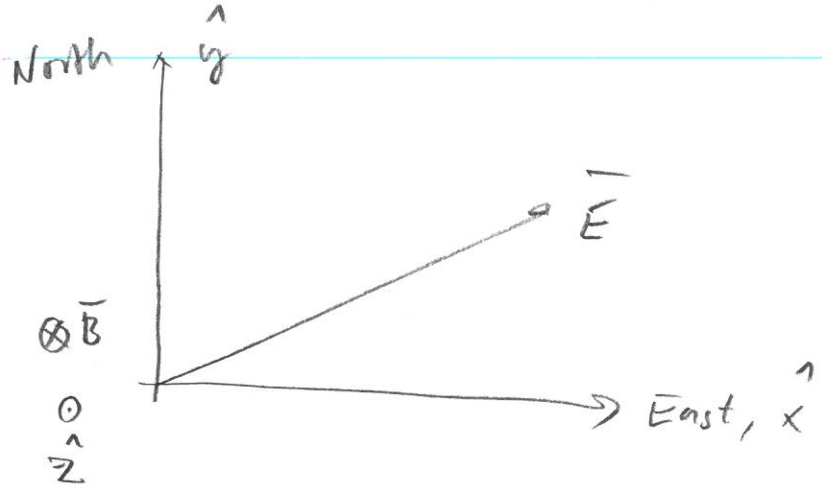
② a) i)

At 150 km:

$\sigma_P = 7 \cdot 10^{-5}$ S/m

$\sigma_H = 10^{-5}$ S/m



$\bar{B} = -B\hat{z}$ (Northern hemisphere)

$\bar{E}_\perp = E_x \hat{x} + E_y \hat{y}$, $E_x = 10$ mV/m, $E_y = 5$ mV/m

$$\bar{j} = \sigma_P \bar{E}_\perp + \sigma_H \frac{\bar{B} \times \bar{E}_\perp}{B} =$$

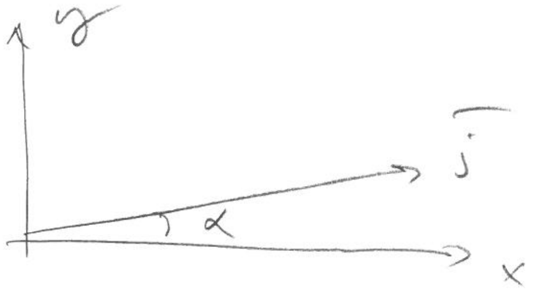
$$= \sigma_P (E_x \hat{x} + E_y \hat{y}) + \sigma_H \left(-\hat{z} \times (E_x \hat{x}) - \hat{z} \times (E_y \hat{y}) \right) =$$

$$= (\sigma_P E_x + \sigma_H E_y)\hat{x} + (\sigma_P E_y - \sigma_H E_x)\hat{x} =$$

$$= (7 \cdot 10^{-5} \cdot 10 \cdot 10^{-3} + 10^{-5} \cdot 5 \cdot 10^{-3})\hat{x} + (7 \cdot 10^{-5} \cdot 5 \cdot 10^{-3} - 10^{-5} \cdot 10^{-3})\hat{y} =$$

$$= 7.5 \cdot 10^{-7} \hat{x} + 2.5 \cdot 10^{-7} \hat{y} \quad (A/m^2)$$

ii)



$$\alpha = \arctan\left(\frac{j_y}{\bar{j}_x}\right) = \arctan\left(\frac{2.5}{7.5}\right) = 18.4^\circ$$

$\bar{j}$ will have an angle of 18° to the Eastward direction