E_y should vanish on the $x=0$ plane, where it is tangential. For $x=0$, $R_1 = R_3$ and $R_2 = R_4$

$$E_y(0,y,z) = \frac{q}{4\pi\varepsilon_0}\left[\frac{(y-b)}{R_1^3} + \frac{y+b}{R_2^3} - \frac{y-b}{R_1^3} - \frac{y+b}{R_2^3}\right] = \underline{0}$$

Find induced σ_f on $y=0$ plane, where E_y is normal.

$$\sigma_f = \varepsilon_0 E_y\Big|_{y=0}$$

$$= \frac{-q}{4\pi}\left[\frac{b}{\sqrt{(x-a)^2+b^2+z^2}} + \frac{b}{\sqrt{(x-a)^2+b^2+z^2}} - \frac{b}{\sqrt{(x+a)^2+b^2+z^2}} - \frac{b}{\sqrt{(x+a)^2+b^2+z^2}}\right]$$

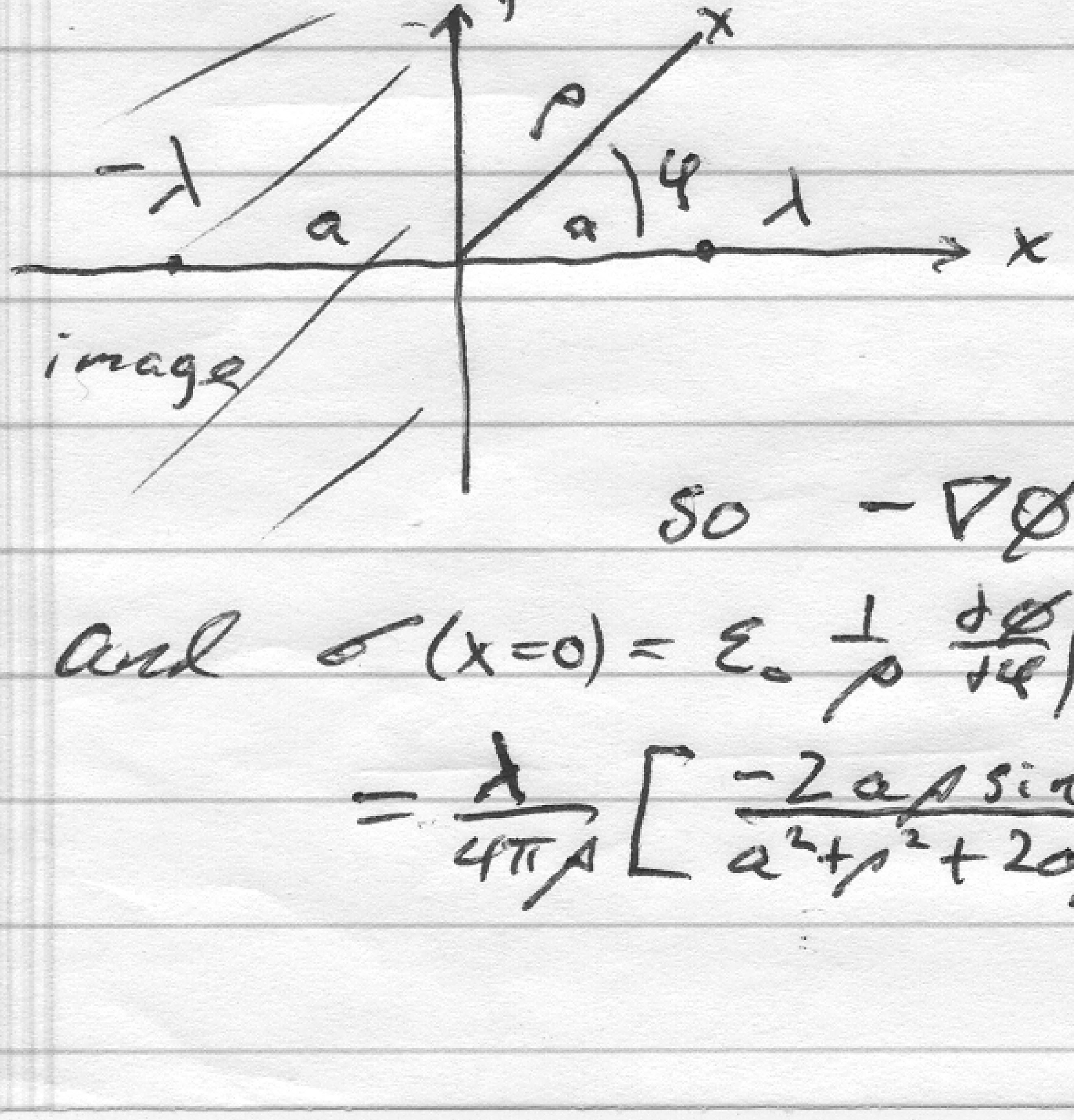
$$\underline{\sigma_f = \frac{-2qb}{4\pi}\left[\frac{1}{\sqrt{(x-a)^2+b^2+z^2}} - \frac{1}{\sqrt{(x+a)^2+b^2+z^2}}\right]}$$

or $\sigma_f = \frac{qb}{2\pi}\left[\frac{1}{\sqrt{(x+a)^2+b^2+z^2}} - \frac{1}{\sqrt{(x-a)^2+b^2+z^2}}\right]$

Since $x>0$, 2nd term is larger than 1st,

so $\underline{\sigma_f < 0}$

W 11-11 from (5-34), $\phi(\rho,\varphi) = \frac{\lambda}{4\pi\varepsilon_0}\ln\left(\frac{a^2+\rho^2+2a\rho\cos\varphi}{a^2+\rho^2-2a\rho\cos\varphi}\right)$



$$\sigma(x=0) = \varepsilon_0 E_x\Big|_{x=0} = -\varepsilon_0 \frac{\partial\phi}{\partial x}\Big|_{x=0}$$

at $x=0$ $\varphi = \pi/2$ and $\hat{x} = -\hat{\varphi}$ for positive y.

so $-\nabla\phi\cdot\hat{x} = \nabla\phi\cdot\hat{\varphi}\Big|_{\pi/2=\varphi} = \frac{1}{\rho}\frac{\partial\phi}{\partial\varphi}\Big|_{\varphi=\pi/2}$

and $\sigma(x=0) = \varepsilon_0 \frac{1}{\rho}\frac{\partial\phi}{\partial\varphi}\Big|_{\pi/2}$

$$= \frac{\lambda}{4\pi\rho}\left[\frac{-2a\rho\sin\varphi}{a^2+\rho^2+2a\rho\cos\varphi} - \frac{2a\rho\sin\varphi}{a^2+\rho^2-2a\rho\cos\varphi}\right]\Bigg|_{\pi/2}$$