1.3

1. $E_\rho = \frac{\lambda}{2\pi\varepsilon_0 a} \sin\theta = \frac{\lambda}{2\pi\varepsilon_0 a} \frac{\frac{1}{2}L}{\sqrt{a^2 + (\frac{1}{2}L)^2}}$

Taylor series: $\frac{z}{\sqrt{z^2+R^2}} = \left(1 + \frac{R^2}{z}\right)^{-1/2}$

$$\frac{\lambda}{2\pi\varepsilon_0 a} \frac{\frac{1}{2}L}{\sqrt{a^2+(\frac{1}{2}L)^2}} = \frac{\lambda}{2\pi\varepsilon_0 a}\left(1 + \frac{a^2}{(\frac{1}{2}L)^2}\right)^{-1/2}$$

As $L \to \infty$,

$$\frac{\lambda}{2\pi\varepsilon_0 a}(1+0) = \frac{\lambda}{2\pi\varepsilon_0 a} = \frac{Q}{2\pi\varepsilon_0 a L}$$

2. $E = \frac{\sigma_0}{\pi\varepsilon_0} \tan^{-1}\left(\frac{w^2}{4z\sqrt{z^2 + w^2/2}}\right)$

Taylor Series: $\frac{\sqrt{b^2}\,\pi}{2b} + \cancelto{0}{O(z^2)} + \left(\cancelto{0}{-\frac{\sqrt{b^2}\,z}{b}} + \cancelto{0}{O(z^3)}\right)$

calculated using Wolfram Alpha

At $z=0$,

$$E = \frac{\sigma_0}{\pi\varepsilon_0}\left(\frac{\pi}{2}\right) = \frac{\sigma_0}{2\varepsilon_0}$$

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