6-19 q is a height z above a planar dielectric

a) $\vec{F} = q\vec{E}_{q'}$

$\vec{E} = \vec{E}_q + \vec{E}_{q'}$ but charges do NOT exhibit self-forces

$\vec{E}_{q'} = \dfrac{q'}{4\pi\varepsilon_0 r^2}$; $q' = -\dfrac{K-1}{K+1}q$ (eqn. 6.64)

$r^2 = (2z)^2 = 4z^2$

$$\vec{F} = \frac{-q^2(K-1)}{4\pi\varepsilon_0(K+1)z^2}$$

b) Surface charge density:

$\vec{E}\cdot\hat{n} = \sigma/\varepsilon_0$

$E_n^{above} - E_n^{below} = \sigma/\varepsilon_0$ $\quad \hat{n} = \hat{k}$

$$\sigma = \varepsilon_0\left[-\frac{\partial V^{above}}{\partial z} + \frac{\partial V^{below}}{\partial z}\right]_{z=0}$$

$$= \frac{\varepsilon_0}{4\pi\varepsilon_0}\left[\frac{-qd + q'd}{(x^2+y^2+d^2)^{3/2}} - \frac{q''d}{(x^2+y^2+d^2)^{3/2}}\right]$$

$$= -\frac{2dq}{4\pi(x^2+y^2+z^2)^{3/2}}\left(\frac{K-1}{K+1}\right)$$