Electricity and Magnetism – Idzerda

Calculate the force (magnitude and direction) experienced by a charge e located at the point $x = d > 0$, $y = z = 0$ outside a dielectric which fills the region $x < 0$ (see figure). The dielectric has dielectric constant ε and the space outside the dielectric (where the charge is located) has dielectric constant ε_0.

(OPTIONAL QUESTIONS TO MAKE IT EASIER)

a) Write the electric field $\boldsymbol{E}(0^+, y, z)$ and $\boldsymbol{E}(0^-, y, z)$ just outside and just inside the dielectric in terms of the charge e and the surface charge densisty σ_b of the bound charges in the dielectric.

b) Express σ_b in terms of $\boldsymbol{E}(0^-, y, z)$.

c) Calculate the electric field $\boldsymbol{E}'$ due to σ_b at the position $(d, 0, 0)$ of the charge e. Show that this can be interpreted as the field of an image charge located at the point $(-d, 0, 0)$.