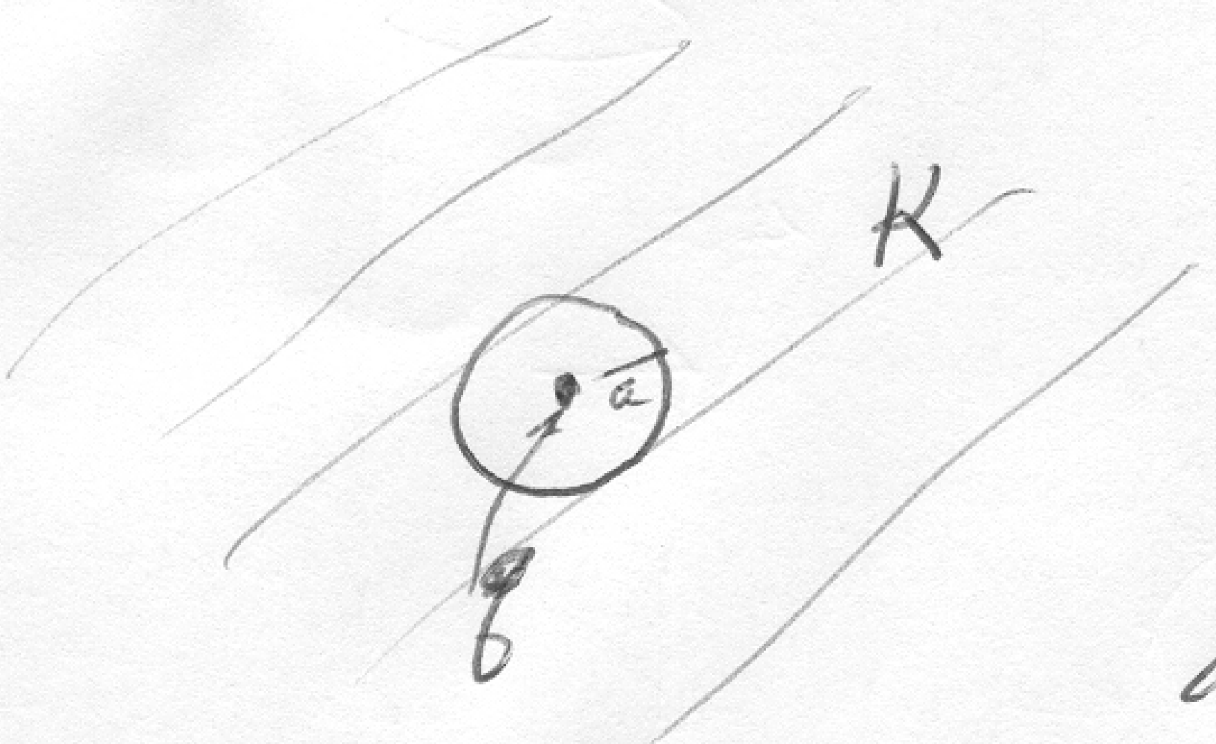
5. W 10-18



Find ρ_b, σ_b

In material, from Gauss' Law for $\vec{D}$, $\vec{D} = \dfrac{q}{4\pi r^2}\hat{r}$ so $\vec{E} = \dfrac{\vec{D}}{\varepsilon} = \dfrac{q}{4\pi\varepsilon}\dfrac{\hat{r}}{r^2}$

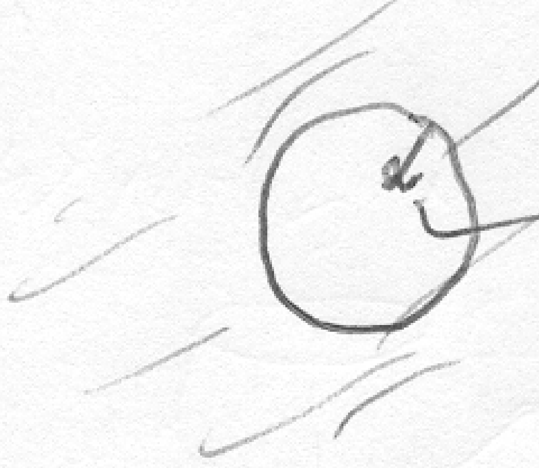
and $\vec{P} = \chi\varepsilon_0\vec{E} = (K-1)\varepsilon_0 E$

$$= \frac{K-1}{K\varepsilon_0}\varepsilon_0\frac{q}{4\pi r^2}\hat{r}$$

$$\vec{P} = \frac{K-1}{K}\frac{q}{4\pi}\frac{\hat{r}}{r^2}$$

$$\rho_b = -\nabla\cdot\vec{P} = -\frac{K-1}{K}\frac{q}{4\pi}\nabla\cdot\frac{\hat{r}}{r^2} = \underline{0} \quad \text{from 1-145}$$

$$\sigma_b = \vec{P}\cdot\hat{n} = \vec{P}\Big|_a\cdot(-\hat{r}) = \underline{-\frac{K-1}{K}\frac{q}{4\pi a^2}}$$



$\hat{n} = -\hat{r}$

$$Q_b = 4\pi a^2\sigma_b = \underline{-\frac{K-1}{K}q}$$

10-13 shows that the total bound charge must vanish. To reconcile our result with this there must be a surface at ∞ with an infinitesimal σ_b with total charge $\dfrac{K-1}{K}q$.