44. (a) The electric field E_1 in the free space between the two plates is $E_1 = q/\varepsilon_0 A$ while that inside the slab is $E_2 = E_1/\kappa = q/\kappa\varepsilon_0 A$. Thus,

$$V_0 = E_1(d-b) + E_2 b = \left(\frac{q}{\varepsilon_0 A}\right)\left(d - b + \frac{b}{\kappa}\right) ,$$

and the capacitance is

$$\begin{aligned} C &= \frac{q}{V_0} = \frac{\varepsilon_0 A\kappa}{\kappa(d-b)+b} \\ &= \frac{\left(8.85\times 10^{-12}\ \frac{\mathrm{C}^2}{\mathrm{N\cdot m}^2}\right)(115\times 10^{-4}\,\mathrm{m}^2)(2.61)}{(2.61)(0.0124\,\mathrm{m} - 0.00780\,\mathrm{m}) + (0.00780\,\mathrm{m})} \\ &= 13.4\ \mathrm{pF} . \end{aligned}$$

(b) $q = CV = (13.4\times 10^{-12}\,\mathrm{F})(85.5\,\mathrm{V}) = 1.15\,\mathrm{nC}$.

(c) The magnitude of the electric field in the gap is

$$E_1 = \frac{q}{\varepsilon_0 A} = \frac{1.15\times 10^{-9}\,\mathrm{C}}{\left(8.85\times 10^{-12}\ \frac{\mathrm{C}^2}{\mathrm{N\cdot m}^2}\right)(115\times 10^{-4}\,\mathrm{m}^2)} = 1.13\times 10^4\ \mathrm{N/C} .$$

(d) Using Eq. 26-32, we obtain

$$E_2 = \frac{E_1}{\kappa} = \frac{1.13\times 10^4\,\mathrm{N/C}}{2.61} = 4.33\times 10^3\ \mathrm{N/C} .$$