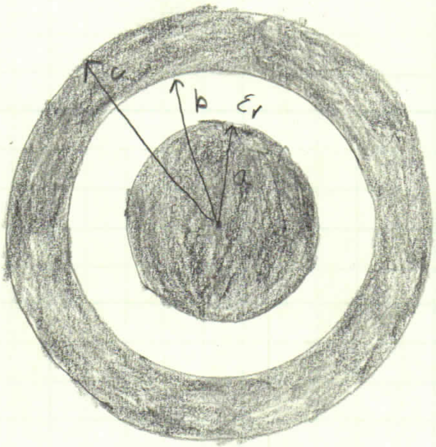
4.21



Assume the copper to be a perfect conductor.

Suppose a charge Q is on the inner cylinder

Then, in the dielectric, $D(2\pi s \ell) = Q$ and so $\vec{D} = \frac{Q}{2\pi s \ell}\hat{s}$

and hence $\vec{E} = \frac{\vec{D}}{\varepsilon} = \frac{\vec{D}}{\varepsilon_0 \varepsilon_r} = \frac{Q}{2\pi\varepsilon_0\varepsilon_r \ell}\frac{\hat{s}}{s}$

and so the potential is

$$V = -\int_a^b \vec{E}\cdot d\vec{l} = -\int_a^b \frac{Q}{2\pi\varepsilon_0\varepsilon_r \ell}\frac{ds}{s} = \frac{Q}{2\pi\varepsilon_0\varepsilon_r \ell}\ln(a/b)$$

and $C = \frac{Q}{V} = Q\left(\frac{2\pi\varepsilon_0\varepsilon_r \ell}{Q\ln(a/b)}\right) = \frac{2\pi\varepsilon_0\varepsilon_r}{\ln(a/b)}$

and so $\frac{C}{\ell} = \frac{2\pi\varepsilon_0\varepsilon_r}{\ln(a/b)}$

!

Notice this is simply the answer to 2.43 multiplied by the factor ε_r.