46. ***REASONING*** Equation 19.10 gives the capacitance as $C = \kappa\varepsilon_0 A/d$, where κ is the dielectric constant, and A and d are, respectively, the plate area and separation. Other things being equal, the capacitor with the larger plate area has the greater capacitance. The diameter of the circle equals the length of a side of the square, so the circle fits within the square. The square, therefore, has the larger area, and the capacitor with the square plates would have the greater capacitance.

To make the capacitors have equal capacitances, the dielectric constant must compensate for the larger area of the square plates. Therefore, since capacitance is proportional to the dielectric constant, the capacitor with square plates must contain a dielectric material with a smaller dielectric constant. Thus, the capacitor with circular plates contains the material with the greater dielectric constant.

SOLUTION The area of the circular plates is $A_{\text{circle}} = \pi\left(\frac{1}{2}L\right)^2$, while the area of the square plates is $A_{\text{square}} = L^2$. Using these areas and applying Equation 19.10 to each capacitor gives

$$C = \frac{\kappa_{\text{circle}}\varepsilon_0\pi\left(\frac{1}{2}L\right)^2}{d} \qquad \text{and} \qquad C = \frac{\kappa_{\text{square}}\varepsilon_0 L^2}{d}$$

Since the values for C are the same, we have

$$\frac{\kappa_{\text{circle}}\varepsilon_0\pi\left(\frac{1}{2}L\right)^2}{d} = \frac{\kappa_{\text{square}}\varepsilon_0 L^2}{d} \qquad \text{or} \qquad \kappa_{\text{circle}} = \frac{4\kappa_{\text{square}}}{\pi}$$

$$\kappa_{\text{circle}} = \frac{4\kappa_{\text{square}}}{\pi} = \frac{4(3.00)}{\pi} = \boxed{3.82}$$