

39. The capacitance is given by $C = \kappa C_0 = \kappa \varepsilon_0 A/d$, where C_0 is the capacitance without the dielectric, κ is the dielectric constant, A is the plate area, and d is the plate separation. The electric field between the plates is given by $E = V/d$, where V is the potential difference between the plates. Thus, $d = V/E$ and $C = \kappa \varepsilon_0 A E/V$. Thus,

$$A = \frac{CV}{\kappa \varepsilon_0 E} .$$

For the area to be a minimum, the electric field must be the greatest it can be without breakdown occurring. That is,

$$A = \frac{(7.0 \times 10^{-8} \text{ F})(4.0 \times 10^3 \text{ V})}{2.8(8.85 \times 10^{-12} \text{ F/m})(18 \times 10^6 \text{ V/m})} = 0.63 \text{ m}^2 .$$