18.55 (a) We want to solve for the voltage when $Q = 2.0 \times 10^{-10}$ C, $A = 650$ mm^2, $l = 4.0$ mm, and ε_r = 3.5. Combining Equations 18.24, 18.26, and 18.27 yields

$$C = \frac{Q}{V} = \varepsilon\frac{A}{l} = \varepsilon_r\varepsilon_0\frac{A}{l}$$

Or

$$\frac{Q}{V} = \varepsilon_r\varepsilon_0\frac{A}{l}$$

And, solving for V, and incorporating values provided in the problem statement, leads to

$$V = \frac{Ql}{\varepsilon_r\varepsilon_0 A}$$

$$= \frac{(2.0 \times 10^{-10}\ \mathrm{C})(4.0 \times 10^{-3}\ \mathrm{m})}{(3.5)(8.85 \times 10^{-12}\ \mathrm{F/m})(650\ \mathrm{mm}^2)(1\ \mathrm{m}^2/10^6\ \mathrm{mm}^2)}$$

$$= 39.7\ \mathrm{V}$$

(b) For this same capacitor, if a vacuum is used

$$V = \frac{Ql}{\varepsilon_0 A}$$

$$= \frac{(2.0 \times 10^{-10}\ \mathrm{C})(4.0 \times 10^{-3}\ \mathrm{m})}{(8.85 \times 10^{-12}\ \mathrm{F/m})(650 \times 10^{-6}\ \mathrm{m}^2)}$$

$$= 139\ \mathrm{V}$$

(c) The capacitance for part (a) is just

$$C = \frac{Q}{V} = \frac{2.0 \times 10^{-10}\ \mathrm{C}}{39.7\ \mathrm{V}} = 5.04 \times 10^{-12}\ \mathrm{F}$$

While for part (b)