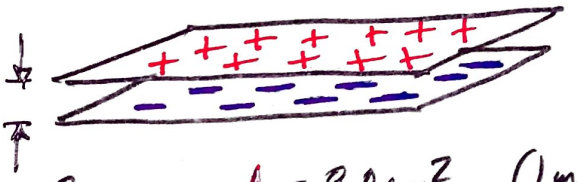
8.51



air-filled capacitor

$d = 1.0e\text{-}3m$ $\quad A = 8.0cm^2 \times \frac{(1m)^2}{(100cm)^2} = 8.0e\text{-}4m^2$

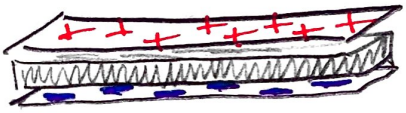
a) $C = \frac{A}{d}\varepsilon_0 = \frac{8e\text{-}4m^2}{1e\text{-}3m} 8.85e\text{-}12 = \boxed{7.08e\text{-}12F}$

$= \boxed{7.1pF}$

b) If $K = 6.0$, $\quad C = KC_0$

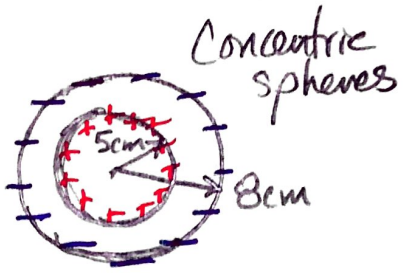
$= 6(7.08e\text{-}12F)$

$= \boxed{4.2e\text{-}11F}$



dielectric

8.52



a) $C = ?$

1. $C = \frac{Q}{\Delta V}$

2. $\Delta V = ?$ $\quad \Delta V = -\int_{r_i}^{r_f} E \cdot dr$ $\quad \Delta V = -\int_{r_i}^{r_f} \frac{kQ}{r^2} dr$

3. $E = ?$

$E = \frac{kq}{r^2}$ (Gauss's Law), so...

$$V_f - V_i = -kQ \left. \frac{-1}{r} \right|_{0.08}^{0.05}$$

$$\Delta V = kQ \left(\frac{1}{0.05} - \frac{1}{0.08} \right)$$

$$\Delta V = kQ(7.5)$$

$$C = \frac{Q}{kQ(7.5)} = \frac{1}{(8.99e9)(7.5)} = \boxed{1.48e{-}11\ F} = \boxed{14.8\ pF}$$

b) If $K = 6.0$, $C = KC_0$

$= (6.0)(1.48e{-}11)$

$= \boxed{8.90e{-}11\ F}$

8.53 $C = 3.00\,\mu F$ (typo in problem)

$Q = 9.00\,\mu C$

Plate separation $d = 2.00e{-}3\,m$

Charge on plates is still $9.00\,\mu C$ after $K = 5.0$ → dielectric has been added between the plates.

a) Find potential between plates before & after filling.

$$\Delta V = \frac{Q}{C} = \frac{9.00e{-}6\,C}{3.00e{-}6\,F} = \boxed{3.0\,V}$$ before

After $\dfrac{9.00e{-}6\,C}{(5)(3.00e{-}6)} = \boxed{0.60\,V}$ after

b) E field between the plates before & after?

$\Delta V = -\int E \cdot dr$. E field between parallel plates is constant, so $\Delta V = -Ed$, &

$$E = -\frac{\Delta V}{d} = \frac{(3\,V)}{(2e{-}3)} = \boxed{1500\,V/m}$$

After $E = \dfrac{(0.6)}{(2e{-}3)} = \boxed{300\,V/m}$

In dielectric (non-conductor) the induced polarization results in an Electric field counter to the one between the plates. The net E field in the region between the plates is reduced.