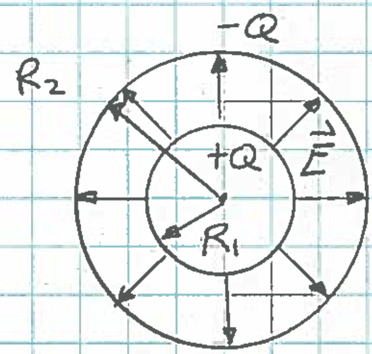

— spherical shell.

a.) from chap 24 (Gauss' Law), we know that the field between the shell is:

$$\vec{E} = \frac{KQ}{r^2}\hat{r} \qquad \text{for} \quad R_1 < r < R_2$$

So the potential between the shell is

$$\Delta V = V(r=R_2) - V(r=R_1) = -\int_{R_1}^{R_2} \vec{E}\cdot d\vec{s}$$

Choose a radial path: $d\vec{s} = dr\,\hat{r}$

So: $\vec{E}\cdot d\vec{s} = \frac{KQ}{r^2}dr$

and,

$$\Delta V = -\int_{R_1}^{R_2} \frac{KQ}{r^2}dr = -KQ\frac{r^{-1}}{-1}\Big|_{R_1}^{R_2} = \frac{KQ}{r}\Big|_{R_1}^{R_2}$$

$$\Delta V = KQ\left(\frac{1}{R_2} - \frac{1}{R_1}\right) < 0$$

$$\Delta V_c = |\Delta V| = KQ\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

and

Capacitance: $C = \frac{Q}{\Delta V_c} = \frac{1}{K}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)^{-1}$

$$C = 4\pi\varepsilon_0\left(\frac{1}{R_1} - \frac{1}{R_2}\right)^{-1}$$

b.) $d = R_2 - R_1 = 1.0\,mm \Rightarrow C = 100\,pF$

Now, $R_2 = R_1 + d$

and

$$C = \frac{1}{K}\left(\frac{1}{R_1} - \frac{1}{R_1+d}\right)^{-1}$$

$$CK = \left(\frac{R_1+d-R_1}{R_1(R_1+d)}\right)^{-1} = \left[\frac{d}{R_1(R_1+d)}\right]^{-1}$$

So,

$$\frac{R_1(R_1+d)}{d} = CK$$

or,

$$R_1^2 + dR_1 - CKd = 0$$

put in number:

$$R_1^2 + (1\times10^{-3})R_1 - 8.99\times10^{-4} = 0$$

$\therefore$ $$R_1 = \frac{-1\times10^{-3} \pm \sqrt{(1\times10^{-3})^2 - 4(-8.99\times10^{-4})}}{2}$$

$$= -5\times10^{-4} \pm 2.999\times10^{-2}$$

$$= \underline{2.949\times10^{-2}},\ -3.049\times10^{-2}\ m$$

physical $\Rightarrow R_1 = 2.949\ cm$

$\therefore$ $R_2 = R_1 + d = 3.049\ cm$

and

$$D_1 = 2R_1 = \underline{5.898\ cm}$$

$$D_2 = 2R_2 = \underline{6.098\ cm}$$