3. W 6-8 Spherical capacitor

$$C = \frac{4\pi\varepsilon_0 ab}{b-a}$$

Let $b = a+\delta$ with $\delta \ll a, b$

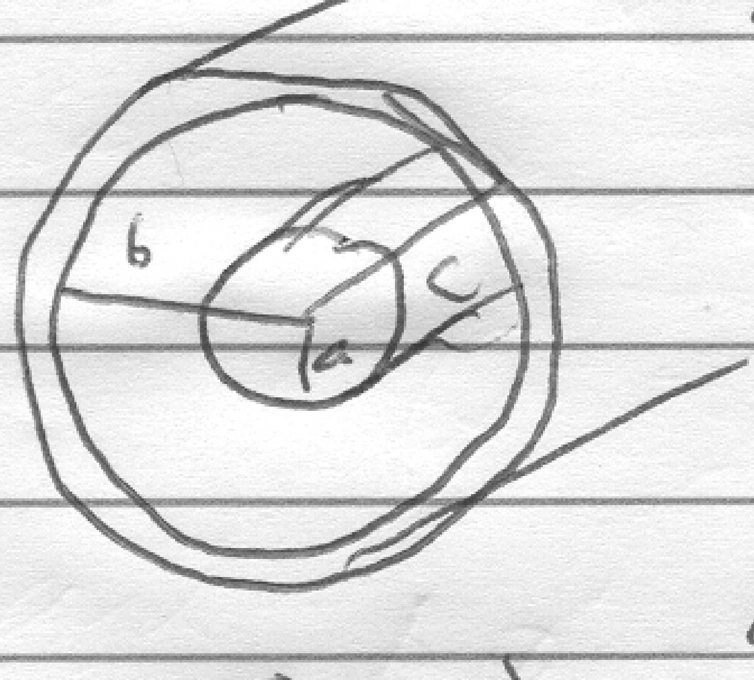
$$C = \frac{4\pi\varepsilon_0 a(a+\delta)}{a+\delta-a} \simeq \underline{\frac{4\pi\varepsilon_0 a^2}{\delta}}$$

Since $4\pi a^2$ = area of sphere & δ = "plate" separation

this is analogous to $\underline{C = \frac{\varepsilon_0 A}{d}}$

for a parallel plate capacitor.

4. 6-10



conductor for $\rho < a$, and $b < \rho < c$.

Find capacitance / length.

Assume $+\lambda$, $-\lambda$ on inner & outer conductors; by Gauss' Law

$$\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 \rho}\hat{\rho} \quad \text{for } a<\rho<b.$$

$$|\Delta\phi| = \left|-\int_a^b \vec{E}\cdot d\vec{s}\right| \qquad d\vec{s} = d\rho\,\hat{\rho}, \text{ so}$$

$$|\Delta\phi| = \left|-\frac{\lambda}{2\pi\varepsilon_0}\int_a^b \frac{d\rho}{\rho}\right| = \left|-\frac{\lambda}{2\pi\varepsilon_0}\ln(b/a)\right| = \frac{\lambda}{2\pi\varepsilon_0}\ln(b/a)$$

for a length l $Q = \lambda l$ so $|\Delta\phi| = \frac{Q}{2\pi\varepsilon_0 l}\ln(b/a)$

$$\underline{C = \frac{Q}{|\Delta\phi|} = 2\pi\varepsilon_0 l \frac{1}{\ln(b/a)}}, \quad \underline{\frac{C}{l} = \frac{2\pi\varepsilon_0}{\ln(b/a)}}$$

inner conductor can be solid or a thin shell without changing E or $|\Delta\phi|$, or C.

E = 0 for $\rho > c$, so C is independent of c