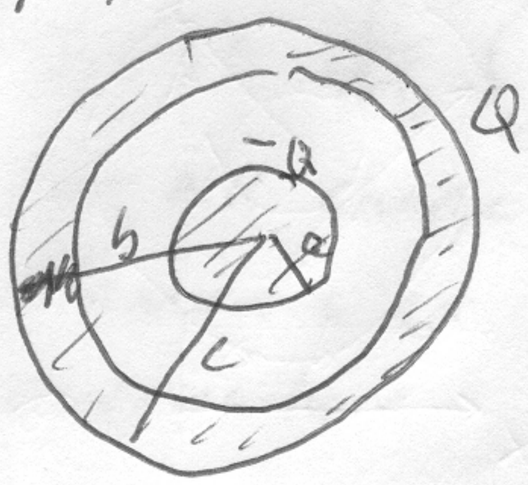
8. 7-10.



Conductors, find energy + C

$\vec{E} = 0$ everywhere except between $r=a$ and $r=b$ where it equals $-\frac{Q}{4\pi\varepsilon_0}\frac{1}{r^2}$

$$U_e = \frac{\varepsilon_0}{2}\int_a^b \frac{Q^2}{(4\pi\varepsilon_0)^2}\frac{1}{r^4}\,4\pi r^2\,dr$$

$$= \frac{1}{8\pi\varepsilon_0} Q^2 \int_a^b \frac{1}{r^2}\,dr$$

$$= -\frac{Q^2}{8\pi\varepsilon_0}\left.\frac{1}{r}\right|_a^b = \frac{Q^2}{8\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{b}\right]$$

$$U_e = \frac{Q^2}{8\pi\varepsilon_0}\left(\frac{b-a}{ab}\right)$$

Now $U_e = \frac{1}{2}\frac{Q^2}{C}$, so $C = 4\pi\varepsilon_0\frac{ab}{b-a}$