chp. 26.

#17. (a). $E(r_a<r<r_b) = \frac{-\lambda}{2\pi\varepsilon_0}\cdot\frac{1}{r}$ $r_a = 0.03\,m$; $r_b = 0.08\,m$

$$\therefore V_b - V_a = -\int_{r_a}^{r_b} E(r)\,dr = -\int_{r_a}^{r_b} \frac{-\lambda}{2\pi\varepsilon_0 r}\,dr = \frac{\lambda}{2\pi\varepsilon_0}\ln r_b/r_a$$

$$\frac{C}{\text{length}} = \frac{\lambda}{V_b - V_a} = 2\pi\varepsilon_0 \frac{1}{\ln r_b/r_a}$$

$$\therefore C = 10\times 2\pi\varepsilon_0 \frac{1}{\ln b/a} = 10\times 2\pi\times\varepsilon_0\times\frac{1}{\ln 8/3} = 5.7\times10^{-10}\,F$$

(b) Energy: $U = \frac{1}{2}QV_{ab} = \frac{1}{2}Q^2/C = \frac{1}{2}CV_{ab}^2 = \frac{1}{2}\times 5.7\times10^{-10}\times(1.0\times10^3)^2 = 2.85\times10^{-4}\,J$

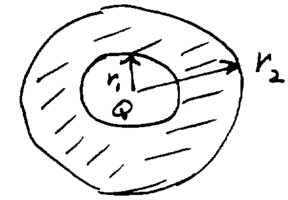
$$U' = \frac{1}{2}V^2C' = \frac{1}{2}\times(1.0)^2\times(10^3)^2\times 5.7\times10^{-11}\times10^3 = 2.85\times10^{-2}\,J$$

#26. The charged sphere is a conductor $\therefore E_{inside} = 0 \Rightarrow U_{inside} = 0$

$$U_{outside} = \int_V u\,dV = \int_{r_1}^{r_2} \frac{\varepsilon_0}{2}E^2\,dV$$

$$E = \frac{Q}{4\pi r^2\varepsilon_0} \quad \text{For } r > r_1$$

$$dV = 4\pi r^2 dr$$



$$\therefore U_{outside} = \int_{r_1}^{r_2}\frac{\varepsilon_0}{2}\left(\frac{Q}{4\pi\varepsilon_0 r^2}\right)^2 4\pi r^2 dr = \frac{Q^2}{8\pi\varepsilon_0}\int_{r_1}^{r_2}\frac{1}{r^2}dr$$

$$= \frac{Q^2}{8\pi\varepsilon_0}\left(-\frac{1}{r}\right)_{r_1}^{r_2} = \frac{(8.5\times10^{-6})^2}{8\pi\times8.85\times10^{-12}}\left(\frac{1}{0.1}-\frac{1}{0.25}\right) = 1.95\,J$$

#30. (a) For $r > R$:

$$\vec{E} = \frac{e}{4\pi\varepsilon_0 r^2}\hat{r} = \frac{-1.6\times10^{-19}}{4\times3.14\times8.85\times10^{-12}}\frac{1}{r^2}\hat{r} = -1.44\times10^{-9}\frac{1}{r^2}\hat{r}$$

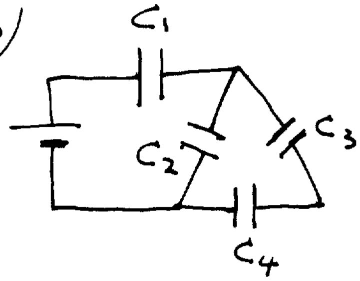
(b) $U(r>R) = \int_V u\,dv = \int_R^\infty \frac{\varepsilon_0}{2}E^2 dV = \int_R^\infty \frac{8.85\times10^{-12}}{2}\times(1.44\times10^{-9})^2\times\frac{1}{r^4}\times4\pi r^2\,dr =$

$$\Rightarrow \quad U(r>R) = \frac{1.15\times10^{-28}}{R}\ J$$

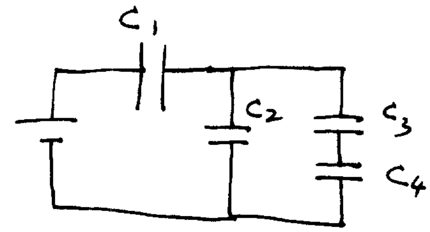
(c) If the energy stored in the electric field is the rest energy

then: $\quad mc^2 = 1.15\times10^{-28}/R \quad \Rightarrow \quad R = \dfrac{1.15\times10^{-28}}{0.9\times10^{-30}\times(3\times10^{8})^2} = 1.4\times10^{-15}\ m.$

#33)



$\Rightarrow$



Thus, C_3 and C_4 are in series: $\quad C_{34} = \dfrac{C_3 C_4}{C_3 + C_4} = \dfrac{2\times5}{2+5} = 10/7$

C_{34} and C_2 are in parallel: $\quad C_{2,34} = C_2 + C_{34} = \dfrac{10}{7} + 4 = 38/7$

Finally C_1 is in series with $C_{2,34}$:

$$\therefore\ C_{tot} = \frac{C_1 \cdot C_{2,34}}{C_1 + C_{2,34}} = \frac{3\times 38/7}{3 + 38/7} = \frac{114}{59} = 1.93\ \mu F$$

#49)

$$\left.\begin{aligned} U_0 &= \tfrac{1}{2}\, Q_0^2/C_0 \\ U &= \tfrac{1}{2}\, Q^2/C \end{aligned}\right\rangle \Rightarrow \quad \frac{U}{U_0} = \left(\frac{Q}{Q_0}\right)^2 \frac{C_0}{\underset{\substack{\uparrow \\ C = \kappa C_0}}{C}} = \left(\frac{Q}{Q_0}\right)^2 \frac{1}{\kappa} = 3$$

$$\Rightarrow \quad Q = 2.3\, Q_0$$

#60) The induced surface charge density:

$$\sigma_{ind} = \sigma - \sigma/\kappa = \sigma\left[1 - \frac{1}{\kappa}\right] = \frac{Q}{L^2}\frac{1}{\kappa}(\kappa - 1)$$

$$Q_{ind} = \sigma_{ind} L^2 = \frac{\kappa - 1}{\kappa} Q = \frac{0.3\times10^{-6}}{2.5}(2.5-1) = 1.8\times10^{-7}\ C$$

The field in the dielectric is

$$E = E_0/\kappa = \sigma/\kappa\varepsilon_0 = Q/L^2\kappa\varepsilon_0 = 0.3\times10^{-6}/[(0.15)^2\times2.5\times 8.85\times10^{-12}]$$
$$= 6.0\times10^5 \ \mathrm{V/m}$$

The energy stored in the capacitor is,

$$U = \frac{1}{2}Q^2/C = \frac{1}{2}Q^2 d/\kappa\varepsilon_0 L^2 = \frac{1}{2}\times(0.3\times10^{-6})^2\times 3\times10^{-3}/[2.5\times 8.85\times10^{-12}\times(0.15)^2]$$
$$= 2.7\times10^{-4}\ \mathrm{J}$$

Chp. 29-8.

The magnetic force produces an acceleration perpendicular to the original motion: $\vec{F} = q\vec{v}\times\vec{B} = m\vec{a}$, or $a_\perp = qvB/m$

The direction of motion is the direction of the velocity.
For a small change in direction, we can take the force to be constant, so the perpendicular component of the velocity is

$$V_\perp = a_\perp t = qvBt/m$$

The direction of motion is given by:

$$\tan\theta = V_\perp/V = qBt/m$$

$$\Rightarrow \quad q = \tan 0.01^\circ \times 0.6\times10^{-3}/0.03\times1 = 3.5\times10^{-6}\ \mathrm{C}$$