ch 25: 3, 4, 10, 17, 24, 27
ch 26: 5, 7, 11, 13, 17

charged earth

25-3) $Q = 30C$

a) $\Delta E = qV = 3 \times 10^5$

b) $KE = \frac{1}{2}mv^2$

$-\Delta V = (\frac{2\times KE}{m})^{\frac{1}{2}} = (\frac{2 \times 3 \times 10^5}{1000})^{\frac{1}{2}}$

$-\Delta V = 734.5 \text{ m/s} \quad \text{(mach 23)}$

c) $\text{mass} \quad \text{work} = \frac{\text{Energy Available}}{\text{Energy axis}} = \frac{9000 \text{ kg}}{734.5 \text{ m/s}} = 734.5 \text{ m/s}$

4)

a) $\Delta V = \frac{\Delta W}{q} = \frac{3.94 \times 10^9}{1 \times 10^6} = 2.5 \text{ V}$

b) moving between some equipotential lines as in a) $\Delta V = 2.5 \text{ V}$

c) moving along one equipotential line, $\Delta V = 0$

10) $E = \frac{\sigma}{\epsilon_0}$ (by Gauss)

a) $\Delta V = \int \frac{\sigma}{\epsilon_0} \cdot \frac{dr}{r} = - \frac{\sigma}{\epsilon_0} \ln r$

$\Delta V = - \frac{\sigma}{\epsilon_0} \ln \frac{r_0}{r}$

$\Delta V = V_0 - V(r)$

b) $W = q \Delta V = q \frac{\sigma}{\epsilon_0} \ln \frac{r_0}{r}$

E-field is pushing in same direction q is traveling, and so does do work.
25. (7)

a) \( V(R) = \frac{1}{4 \pi \varepsilon_0} \frac{q}{r} \) \( \Rightarrow \) from point charge or \( V(R) = 500 \text{V} \) from spherically symmetric charge

\[ R = \frac{1}{4 \pi \varepsilon_0} \frac{q}{V} = \frac{3 \times 10^{-6} \text{C}}{4 \pi \varepsilon_0 \times 500 \text{V}} = 3 \times 10^{-12} \text{m} \]

b) find i) radius of new drop \( R_{\text{new}} \) then calculate \( V \) at surface

ii) charge of new drop \( Q_{\text{new}} \)

\[ V_{\text{new}} = \frac{1}{4 \pi \varepsilon_0} \int \frac{Q_{\text{new}}}{R_{\text{new}}} \]

\[ R_{\text{new}} = 2^{1/3}R \]

\[ Q_{\text{new}} = 2Q \]

\[ V_{\text{new}} = 74.4 \text{V} \]

26)

V potentials add up:

we did this in class.

Also, basic law formula for:

\[ V_1 = V_2 \]

\[ ZV_1 = Z \frac{A \left( \frac{L(L + d)^2}{4d} \right)}{4 \pi \varepsilon_0} \]

... with a little effort we can see that this is equal to what we found in class.

b) \( V = V_1 + V_2 \), \( V_1 = -V_2 \) \( \Rightarrow \) \( V = 0 \)
ch 25.47

\[ V = V_0 + V_e = 2V_0 \]
\[ = 2 \frac{1}{4\pi\varepsilon_0} \frac{1.6 	imes 10^{-19} C}{0.01 m} \]
\[ = 2.88 \times 10^{-7} V \]
\[ V_e = \left( \frac{2qV_0}{4\pi\varepsilon_0} \right) = 318 \mu V \]

ch 26.5

a) \[ C = \frac{\varepsilon_0 A}{d} = \varepsilon_0 \frac{\pi (0.022 m)^2}{(1.3 \times 10^{-3} m)} = 0.1 \mu F \]

b) \[ g = CV = (0.1 \mu F) (6 \times 10^{-4} V) = 6 \times 10^{-6} \]

7)

\[ \text{as in 25.7} \quad R_n = 2^{1/2} R \]

\[ C_n = \varepsilon_0 \varepsilon_n R_n = \varepsilon_0 \varepsilon_0 \left( 2^{1/2} R \right) \]

\[ \text{in parallel:} \quad C_{\text{tot}} = \varepsilon_0 C = NC \quad \text{for} \ \text{N parallel caps} \]

\[ N = \frac{C_{\text{tot}}}{C} = \frac{qe^{-3F}}{1e^{-6F}} = 9000 \]

\[ C = 1 \mu F \]

\[ Q_{\text{tot}} = C_{\text{tot}} V \quad \Rightarrow \quad C_{\text{tot}} = \frac{Q_{\text{tot}}}{V} = \frac{1C}{110V} = 9e^{-3} F \]
\(C_{eq} = C_1 + C_2\)

\(C_{eq} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}\)

\(C_{eq} = \frac{1}{\frac{1}{C_{eq12}} + \frac{1}{C_3}} = \frac{1}{\frac{1}{C_{eq12}} + \frac{1}{C_3}}\)

\(C_{eq12} = 2.2 \mu F\)

\(C_1 = 100 \mu F\)

\(V_B = 25 V\)

\(q_{eq} = C_1 V_B = 3.5e-9 C\)

\(q_{tot} = q_{1} + q_{2}\)

\(q_{2} = C_1 V_B = 3.5e-9 C\)

\(q_{1} = q_{tot} - q_{2} = (5e-9 C - 3.5e-9 C)\)

\(q_{z} = 1.5e-9 C\)

\(C_2 = \frac{q_{z}}{V_B} = 4.7 \mu F\)
charged Earth Problem

a) done

b) \[ F_c = 0.0001 F_g \]
\[ \frac{1}{4\pi \varepsilon_0} \frac{q^2}{r^2} = (0.0001) \frac{G \frac{M_1 M_2}{r^2}}{r^2} \]
\[ q = \frac{3}{(0.0001) \frac{4\pi \varepsilon_0 G M_1 M_2}{3}} \]
\[ q = 3.315 \text{ coulombs} \]

\[ G_0 = 8.85 \times 10^{-12} \text{ N m}^2 \text{ C}^{-2} \]
\[ G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \]
\[ M_1 = 6.2 \text{ kg} \]
\[ M_2 = 2.3 \text{ kg} \]
\[ R_E = 6.4 \text{ km} \]

\[ \text{c) Earth} = \frac{\text{total charge}}{\text{surface area}} = \frac{3.315 \text{ C}}{4\pi R_E^2} = 5.8 \text{ C/m}^2 \]

d) can do this one of two ways:

1) assume all charge at center of Earth (with is the same)
\[ |E| = \frac{1}{4\pi \varepsilon_0} \frac{Q_{net}}{R_E^2} \]

2) assume a flat Earth (or at least a fairly flat region on the surface).

Gauss' law: \[ \int \vec{E} \cdot d\vec{A} = \frac{q_{\text{enc}}}{\varepsilon_0} \]
\[ A = \frac{\int \vec{E} d\vec{A}}{\varepsilon_0} = \frac{E}{G_0} = \frac{5.8 \text{ C}^2}{8.85 \times 10^{-12} \text{ N m}^2} = 6.6 \text{ km} \]