Ch 17 Problems

1) $W = -\Delta PE = qV = (-5.00\times10^{-6}\,C)(150V) = \boxed{-7.5\times10^{-4}\,J}$

5) a) $\Delta V = Ed = (3.0\times10^{4}\,V/m)(1000\,m) = \boxed{3.0\times10^{9}\,V}$

b) $\sigma = \frac{Q}{A}$ $\quad C = \frac{Q}{V} = \frac{\varepsilon_0 A}{d}$

$Q = \frac{\varepsilon_0 A V}{d} = \frac{(8.85\times10^{-12}\,F/m)(2.0\,km^2)\left(\frac{1000\,m}{km}\right)^2(3e9V)}{1000\,m}$

$= \boxed{53.1\,C}$

9) a) $V_e = \frac{kQ}{r}$

$V_{grav} = \frac{GM}{r}$

b) $V_1 = \frac{GM_e}{\Delta r}$ $\quad V_0 = 0$

$r = \left(\sqrt{5^2+2.5^2}\right)m$

$= \frac{(6.67\times10^{-11}\,\frac{Nm^2}{kg^2})(5.97\times10^{24}\,kg)}{\sqrt{5^2+2.5^2}}$

$= \boxed{7.12\times10^{13}\,J/kg}$

13) a) $\frac{Q}{m^2} = \sigma = E\varepsilon_0$

$= (1.00\times10^{4}\,N/C)(8.85\times10^{-12}\,F/m)$

b) $\frac{Q}{A} = 8.85\times10^{-8}\,C/m^2$ $= \boxed{8.85\times10^{-8}\,C/m^2}$

c) $V = Ex = (1.0e4\,N/C)(0.1\,m)$

$= \boxed{1.0\times10^{3}\,V}$

d) $qE = mg$

$q = \frac{mg}{E} = \frac{(1.00\times10^{-5}\,kg)(9.8\,m/s^2)}{1.0e4\,N/C}$

$= \boxed{9.8\times10^{-9}\,C}$

17) $V_g = \frac{PE_g}{m}$

21) $V = \frac{kQ}{r}$ $\quad V = -\int E \cdot dr$

$= -\int \frac{kQ}{R^2}\,dR$

$= -kQ\int R^{-2}\,dR$

$= \frac{kQ}{R} = V$

$R = \frac{kQ}{V} = (9e9\,\frac{Nm^2}{C^2})C$

$V = -Er$ $\quad r = \frac{V}{-E} = \frac{25\,kV}{3e6\,V/m}$

$= 0.0083\,m$

minimum b/c if it's bigger the charges are more and the field will be less.

25) a) $V = \frac{kQ_+}{r} + \frac{kQ_-}{R}$

$= \frac{kZe}{r} + \frac{-kZe}{R}$

$= kZ\left(\frac{e}{r} - \frac{e}{R}\right)$

b) $V = \frac{kZe}{r} - \frac{kZe}{r} = 0$

29) b) $V_0 = \frac{kQ}{2R}\left(3 - \frac{r^2}{R^2}\right)$

$= \frac{k3Q}{2R} = \frac{(9e9)(3)(6e^{-9}\,C)}{2(0.05\,m)}$

$= \boxed{1.62\times10^{3}\,V}$

a) $V_{surface} = \frac{kQ}{2R}\left(3 - \frac{R^2}{R^2}\right)$

$= \frac{kQ}{R} = \frac{(9e9)(6e^{-9}C)}{(0.05\,m)} = \boxed{1.08\times10^{3}\,V}$

33) a) $V_1 = \frac{kQ}{r} = \frac{(9e9)(3e^{-9}C)}{(0.02\,m)} = \boxed{1.35\times10^{3}\,V}$

$V_2 = \frac{kQ}{R} = \frac{(9e9)(3e^{-9}C)}{0.04\,m} = \boxed{6.75\times10^{2}\,V}$

b) $\Delta V = 0$ $\quad \frac{q}{Q} = \frac{r}{R}$

$\frac{q}{Q} = 0.5 \quad q = \frac{2(3e^{-9}C)}{3}$

$= 2\times10^{-9}\,C$

$Q = 4\times10^{-9}\,C$

1nC was transferred.

37) ~~U=EA~~ $V = -\int E\cdot dr$

$= -\int_a^r \frac{k2\lambda}{r}\,dr$

$= -2k\lambda(\ln|r| - \ln|a|)$

$= \boxed{-2k\lambda \ln\left|\frac{r}{a}\right|}$

b) $V(r)$ is >0 when $\ln\left|\frac{r}{a}\right| < 0$ when $r<a$

c) $V(r) < 0$ when $r > a$

d) r can't be 0 or ∞ bc ln would be undefined.

e) $E_r = -\frac{dV}{dr}\hat{r}$

$V = -2k\lambda(\ln|r| - \ln|a|)$

$-\frac{dV}{dr} = \frac{+2k\lambda}{r}$ ✓

41) $\Delta KE = -\Delta PE = -qV = -(-1e)(1000\,eV)$

$= \boxed{1000\,eV}$

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

$v_f = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(1000)(1.602\times10^{-19}J)}{(9.11\times10^{-31}kg)}}$

$= \boxed{1.88\times10^{7}\,m/s}$

48) a) near the 0V sheet

b) $\Delta KE = qV = (1e)(200V) = \boxed{200\,eV} = \boxed{3.20\times10^{-17}\,J}$

c) $v_f = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(3.20\times10^{-17}J)}{(9.11\times10^{-31}kg)}}$

$= \boxed{8.38\times10^{6}\,m/s}$

49) a)

c) $E = \frac{1}{2}mv_0^2$

$= \frac{1}{2}(9.11\times10^{-31}kg)(5e7\,m/s)^2$

$= 1.14\times10^{-15}\,J$

$\approx 1.6\times10^{-16}\,J$ (PE)

d) $\Delta KE = -qV = -(-e)(-1000V)$

$= -1000\,eV = -1.602\times10^{-16}\,J$

$KE_f = 9.80\times10^{-16}\,J$

e) $v_f = \sqrt{\frac{2KE_f}{m}} = \sqrt{\frac{2(9.80\times10^{-16}J)}{9.11\times10^{-31}kg}}$

$= \boxed{4.64\times10^{7}\,m/s}$

53) a) $\Delta KE = -qV = -(2e)(20V) = -40\,eV$

b) $\Delta KE = -(2e)(-30V) = +60\,eV$

57) a) $V = \frac{kQ}{R}$

b) $PE = qV = -\frac{kQq}{R}$

c) $\frac{1}{2}mv_{esc}^2 + -\frac{kQq}{R} = 0$

$\frac{1}{2}mv_{esc}^2 = \frac{kQq}{R}$

$v_{esc}^2 = \frac{2kQq}{mR}$

$v_{esc} = \sqrt{\frac{2kQq}{mR}}$

d) $v_{esc_{grav}}$ indep. of m

b/c $\frac{1}{2}mv^2$ and $\frac{GMm}{r}$

cancels out the m, and here it's the charge

e) $v_{esc}^2 = \frac{2kQq}{mR}$

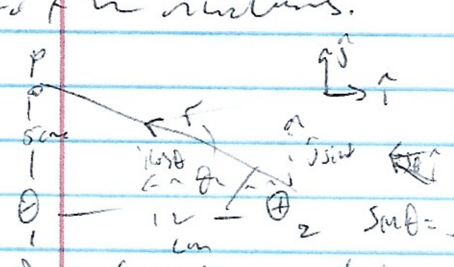
$Q = \frac{v_{esc}^2 mR}{2kq} = \frac{(3e8\,\frac{m}{s})^2(9.11\times10^{-31}\,kg)(10^{-14}\,m)}{2(9e9\,\frac{Nm^2}{C^2})(1.602\times10^{-19}\,C)}$

$= 2.84\times10^{-19}\,C$

about 1-2 protons

f) b/c the electrons are further away they will never get that close to the nucleus.

61) a)



$\sin\theta = \frac{5}{r}$

$E_1 = \frac{kQ_1}{r^2} = \frac{(9e9)(-3.0\times10^{-6}\,C)}{(0.05\,m)^2}\,\hat{j}$

$E_1 = -1.08\times10^{7}\,\frac{N}{C}\,\hat{j}$

$E_2 = \frac{k|Q|}{r^2} = \frac{(9e9)(2.0\times10^{-6}\,C)}{(\sqrt{0.12\,m^2 + .05\,m^2})^2}(\hat{j}\sin\theta - \hat{i}\cos\theta)$

$\sin\theta = \frac{5}{\sqrt{12^2+5^2}}$ $\cos\theta = \frac{12}{\sqrt{12^2+5^2}}$

$= \cancel{1.33\times10^{6}\,\frac{N}{C}}$

$4.10\times10^{5}\,\frac{N}{C}\,\hat{j} - 9.83\times10^{5}\,\frac{N}{C}\,\hat{i}$

$E_{Total} = -1.04\times10^{7}\,\frac{N}{C}\,\hat{j} - 9.83\times10^{5}\,\frac{N}{C}\,\hat{i}$

b) $V = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2} = k\left(\frac{(-3.00\times10^{-6}\,C)}{(0.05\,m)} + \frac{(2e^{-6}\,C)}{\sqrt{.12^2+.05^2}}\right)$

$= \boxed{-4.02\times10^{5}\,V}$

c) $PE_{dip} = -\vec{p}\cdot\vec{E}$ $\hat{j}\cdot\hat{j} = 1$ $\hat{i}\cdot\hat{j} = 0$

$= -(6.0\times10^{-30}\,C\cdot m)(-1.04\times10^{7}\,\frac{N}{C})$

$= 6.24\times10^{-23}\,J$

d) $\tau = \vec{p}\times\vec{E}$ $\hat{j}\times\hat{j} = 0$ $\hat{j}\times\hat{i} = -\hat{k}$

$= (6.0\times10^{-30}\,C\cdot m)\,\hat{j} \times (-9.83\times10^{5}\,\frac{N}{C})\,\hat{i}$

$= \boxed{(5.90\times10^{-24}\,N\cdot m)\,\hat{k}}$

65) $PE = k\left(\frac{Q_1Q_2}{r_{12}} + \frac{Q_1Q_3}{r_{13}} + \frac{Q_2Q_3}{r_{23}}\right)$

$= \frac{(9e9\,\frac{Nm^2}{C^2})}{(1.30\times10^{-15}\,m)}\left(\frac{2}{3}e\cdot\frac{2}{3}e + \frac{2}{3}e\cdot-\frac{1}{3}e + \frac{2}{3}e\cdot-\frac{1}{3}e\right)$

$= 0\,J$

69) $PE_{dip} = -\vec{p}\cdot\vec{E}$ $\hat{p}\cdot\hat{p} = 1$

$PE_{dip} = -\vec{p}_1\cdot\vec{E}_2$

$E_2 = \frac{k2p_2}{r^3}\,\hat{p}$

$PE_{dip} = -\frac{k2p_1p_2}{r^3}$