Ch 17 ex

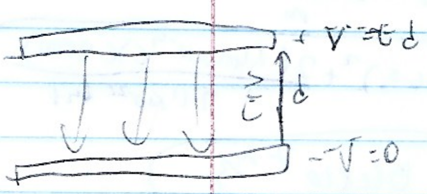
1) $\Delta V = -\int E\, dr$ → uniform field,

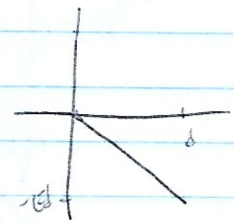
$\Delta V = -E \cdot x$

b) whole distance, $x = d$

$\Delta V = -Ed$

c) (−) plate is 0




2) a) $V = \frac{kQ}{r} = \frac{(9e9 \frac{Nm^2}{C^2})(1.602\times10^{-19}\,C)}{(5.29\times10^{-11}\,m)}$

$= \boxed{27.3\ V}$

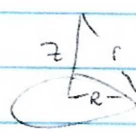
b) $PE = qV = (-1.602\times10^{-19}\,C)(27.3\,V)$

$= \boxed{-4.37\times10^{-18}}$

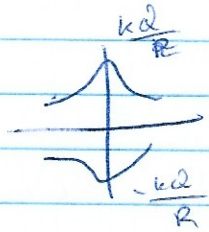
3) $V = \frac{kQ}{r} = \frac{(9e9)(-3.0\times10^{-9}\,C)}{(0.05\,m)}$

$= \boxed{-540\,V}$

4) $V = \frac{kQ}{r} = \frac{kQ}{\sqrt{z^2+R^2}}$




scalar




5) $\sigma = \frac{Q}{\pi R^2}$ add up each disk - ring of area $2\pi r\, dr$

$dQ = \sigma(2\pi r)\,dr$

$dV = \frac{k\, dQ}{\sqrt{z^2+r^2}}$

$V = k\int_0^R \frac{\sigma 2\pi r\, dr}{\sqrt{(z^2+r^2)}}$

$u = z^2 + r^2 \quad \frac{du}{dr} = 2r \quad dr = \frac{du}{2r}$

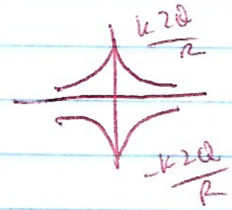
$V = k\int_0^R \frac{\sigma \pi\, du}{\sqrt{u}}$

$= k\sigma\pi \int_0^R u^{-1/2}\, du$

$= 2k\sigma\pi \left(\sqrt{z^2+R^2}\right)\Big|_0^R$

$= 2k\sigma\pi\left(\sqrt{z^2+R^2} - z\right)$

$\sigma = \frac{Q}{\pi R^2}$ → $V = \frac{k2Q}{R^2}\left(\sqrt{z^2+R^2} - z\right)$



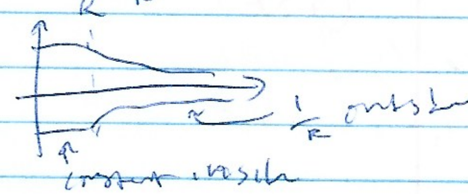

6) $V = \frac{kQ}{r} \quad r > R$

if $r = R$, then $V = \frac{kQ}{R}$

7) charge goes to the surface.

V = constant inside.

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




8) E inside sphere $\int E \cdot ds = \frac{Q_{enc}}{\epsilon_0}$

$E \cdot 4\pi R^2 = Q \cdot \frac{r}{R\epsilon_0}$

$E = \frac{kQr}{R^3}$

$V = \int E \cdot dr = -\int \frac{kQ}{R^3} r\, dr$

$= -\frac{1}{2}\frac{kQr^2}{R^3}$

$= \frac{-kQr^2}{2R^3}$

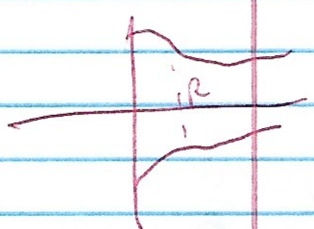
$$V = -\frac{kQ}{R^3}\int_R^r r\,dr$$

$$= -\frac{kQ}{R^3}\left(\frac{1}{2}r^2\right)_R^r$$

$$= \frac{kQ}{R^3}\left(\frac{1}{2}R^2 - \frac{1}{2}r^2\right)$$

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

at the surface, $V = \frac{k3Q}{2R}$



a) $E_z = \frac{-\partial V}{\partial z} = -\frac{dV}{dz} = -kQ\left(-\frac{1}{2}\right)\frac{2z}{(z^2+R^2)^{3/2}}$

$$= \frac{kQz}{(z^2+R^2)^{3/2}}$$

b) $\cancel{PE_0} + KE_0 = \cancel{PE_f} + KE_f$

$q\Delta V + \frac{1}{2}mv_0^2 = \frac{1}{2}mv_f^2$

$v_f^2 = \frac{\cancel{m}v_0^2}{\cancel{m}} + \frac{2q\Delta V}{m}$

$v_f = v_0 + \sqrt{\frac{2q\Delta V}{m}}$

$= (5e6\ \text{m/s}) + \sqrt{\frac{2(1.602\times10^{-19}\,C)(250V)}{(9.11\times10^{-31}\,kg)}}$

$= \boxed{1.44\times10^{7}\ \text{m/s}}$

$\Delta KE = -\Delta PE = -q\Delta V$

$\frac{mv_f^2}{2} - \frac{mv_0^2}{2} = e\Delta V$

$v_f^2 = v_0^2 + \frac{2e\Delta V}{m}$

$v_f = \sqrt{v_0^2 + 2\frac{e\Delta V}{m}}$

$= \sqrt{(5e6\ \text{m/s})^2 + \frac{2(1.602\times10^{-19}\,C)(250V)}{9.11\times10^{-31}\,kg}}$

$= \boxed{1.06\times10^{7}\ \text{m/s}}$

(1) $\Delta KE = -qV = -(-1.602\times10^{-19}\,C)(250V)$

$= +250\ eV$

$= 4.01\times10^{-17}\ J$

(2) a) the 250V plate

b) $\Delta KE = -\Delta PE = qV$

$= (1e)(250V)$

$= 250\ eV$

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

$v = \sqrt{\frac{2\Delta KE}{m}} = \sqrt{\frac{2(250\,eV)(1.602\times10^{-19}\,J/eV)}{(1.67\times10^{-27}\,kg)}}$

$= \boxed{2.19\times10^{5}\ \text{m/s}}$

d) no

(3) $KE_f = -qV = -(2e)(-1000\,V)$

$= \boxed{2000\ eV}$

(4) a) $PE = \frac{k|Q_1||Q_2|}{r} = \frac{(9e9\ \frac{Nm^2}{C^2})(0.66\cdot1.602e^{-19})^2}{(0.257e^{-9}\ m)}$

$= \boxed{1.76\times10^{-18}\ J}$

$= 11\ eV$

c) $PE = -1.76e^{-18}\ J = -11\ eV$

b) Work is (+)

15) $PE = k\left(\frac{Q_H Q_C}{r_{HC}} + \frac{Q_H Q_O}{r_{HO}} + \frac{Q_N Q_C}{r_{NC}} + \frac{Q_N Q_O}{r_{NO}}\right)$

$= (9e9 \frac{Nm^2}{C^2})\left(\frac{0.19e \cdot 0.4e}{0.3\,nm} + \frac{(0.19e)(-0.4e)}{0.18\,nm}\right.$

$\left. + \frac{(-0.19e)(0.4e)}{0.4\,nm} + \frac{(-0.19e)(-0.4e)}{0.28\,nm}\right)$

$= -0.13\cancel{5}\ eV$