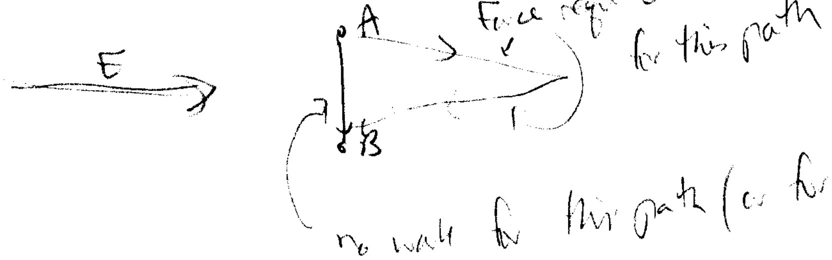
Homework 4

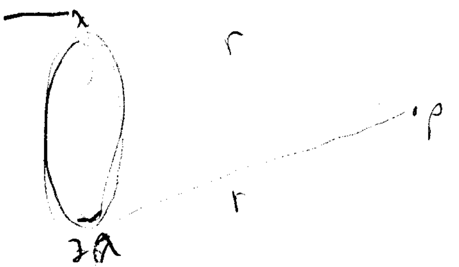
Q 1, 12
P 1, 4, 30, 52

Ch 23

Q1 No net work and thus no net force must be exerted. However, depending on the path work may be done at certain parts; eg



Q12



distance from each charge doesn't change, so V doesn't change at this point

direction of $\vec{E}$ (a vector) changes

P1 $\Delta U = qV_{BA}$

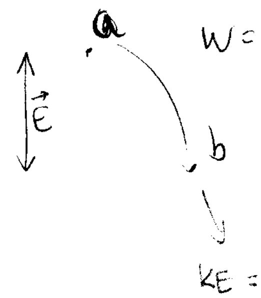
change in potential energy ↔ change in kinetic energy

$$\frac{1}{2}mv^2 = qV$$

$$\boxed{V = \frac{mv^2}{2q}}$$

HW 4

P4



$W = 7 \times 10^{-4} J$

$Q = -9.10 \mu C$

Potential difference does work and so does the electric field

$W_{ext} + W_{elec} = \Delta KE$

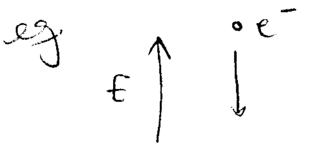
$W_{ext} + [-q(V_b - V_a)] = \Delta KE$

$V_b - V_A = \frac{\Delta KE - W_{ex}}{-q}$

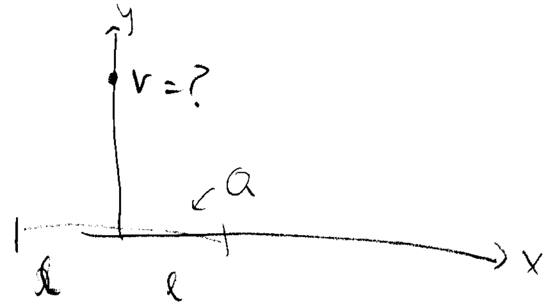
$= \frac{(2.1 \times 10^{-4} J) - (7 \times 10^{-4} J)}{+(+9.1 \times 10^{-6} C)}$

$\boxed{V_b - V_a = -53.8 \, V}$ so $V_a > V_b$

e.g.



p 38



Use $V = \frac{1}{4\pi\epsilon_0}\int\frac{dq}{r}$ (assume V=0 at ∞)

$dq = \lambda\, dl$

$\lambda = \frac{Q}{2l}$

$dl = dx$

$r = \sqrt{x^2+y^2}$

$$V = \frac{1}{4\pi\epsilon_0}\int_{-l}^{l}\frac{\frac{Q}{2l}\,dx}{\sqrt{x^2+y^2}}$$

$$= \frac{Q}{2l4\pi\epsilon_0}\int_{-l}^{l}\frac{dx}{\sqrt{x^2+y^2}}$$

see Appendix B-4:

$$\frac{dx}{\sqrt{x^2+a^2}} = \ln(x+\sqrt{x^2+a^2})$$

$$= \frac{Q}{8l\pi\epsilon_0}\left[\ln(x+\sqrt{x^2+y^2}\right]_{-l}^{l}$$

$$\boxed{V = \frac{Q}{8l\pi\epsilon_0}\left(\ln(l+\sqrt{l^2+y^2}) - \ln(-l+\sqrt{l^2+y^2})\right)]}$$

$$= \frac{Q}{8\pi l\epsilon_0}\ln\left(\frac{\sqrt{l^2+y^2}+l}{\sqrt{l^2+y^2}-l}\right)$$

hw 4

52

$m = 0.050\ g$

$q = 2 \times 10^{-6}\ C$

$V(x) = 2\ V/m^2\ x^2 - 3\frac{V}{m^3} x^3$

$X_i = 2.0\ m$

$F = m\vec{a} = q\vec{E}$

$a = \frac{q}{m}\vec{E}$

$$\vec{E} = -\vec{\nabla} V$$

$$= \frac{\partial}{\partial x} V(x)\,\hat{i} + \cancelto{0}{\frac{\partial}{\partial y} V(x)}\,\hat{j} + \cancelto{0}{\frac{\partial}{\partial z} V(x)}\,\hat{k}$$

$$= \left(2\frac{V}{m^2}\, 2x - \frac{3V}{m^3}\, 3x^2\right)\hat{i}$$

$$\vec{a} = \frac{q}{m}\left(4\frac{V}{m^2}\, x - 9\frac{V}{m^3}\, x^2\right)\hat{i}$$

at $x = 2$

$$\vec{a} = \left(\frac{(2\times 10^{-6})}{(0.05\times 10^{-3}\,kg}\right)\left(4\frac{V}{m^2}(2m) - 9\frac{V}{m^3}(2m)^2\right.$$

$$\vec{a} = \boxed{1.1\ m/s^2}\,\hat{i}$$