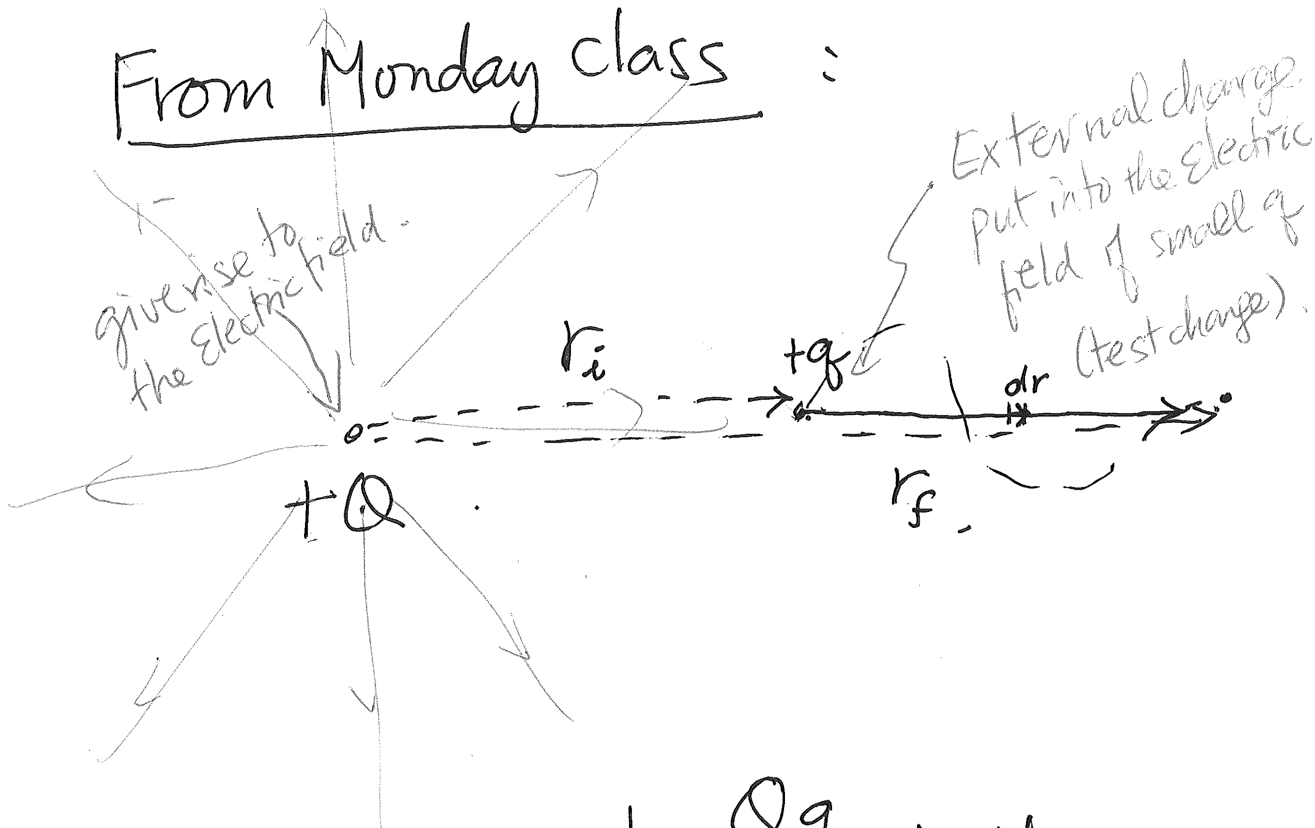
From Monday class :



$$F_E = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$$ in the same direction as dr.

Work done by F_E dot product

Potential Energy

$$= \int \vec{F}_E \cdot d\vec{r}$$

$U_f - U_i$

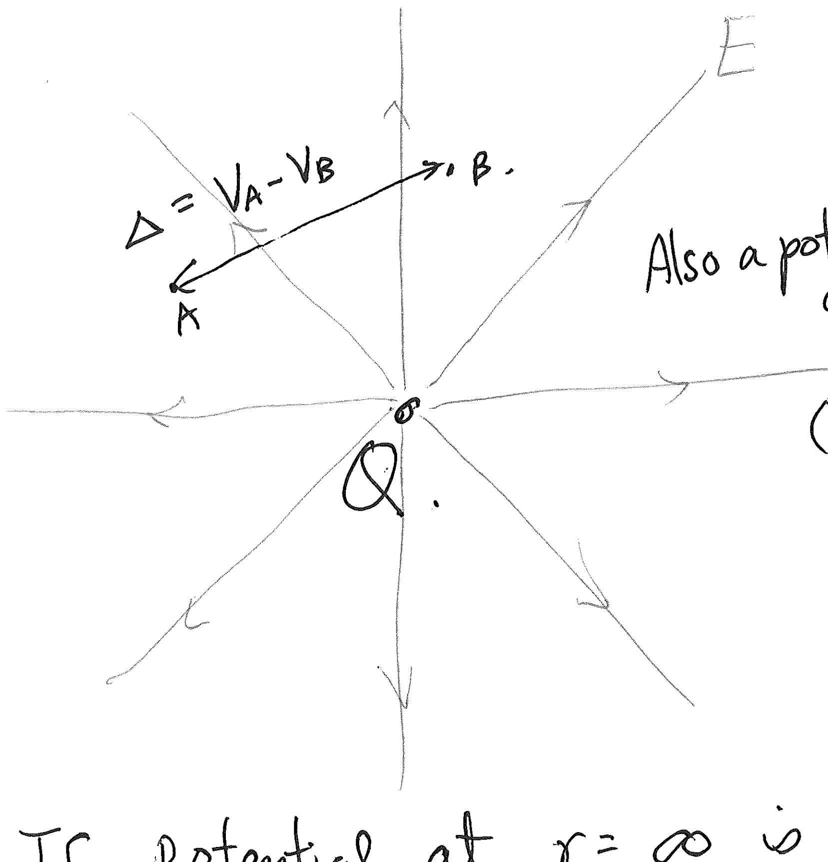
$$= \int_{r_i}^{r_f} \left(\frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}\right)(dr)\cos 0^\circ$$

$= -W$

$$= \frac{Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_f} - \frac{1}{r_i}\right). \qquad = \left[-\frac{1}{4\pi\varepsilon_0}\frac{Qq}{r}\right]_{r_i}^{r_f} = \frac{Qq}{4\pi\varepsilon_0}\left(\frac{1}{r_i} - \frac{1}{r_f}\right).$$

$$\text{Change in Potential} = \frac{\text{Change in potential Energy}}{q}.$$

$$\text{Change in potential} = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r_f} - \frac{1}{r_i}\right).$$



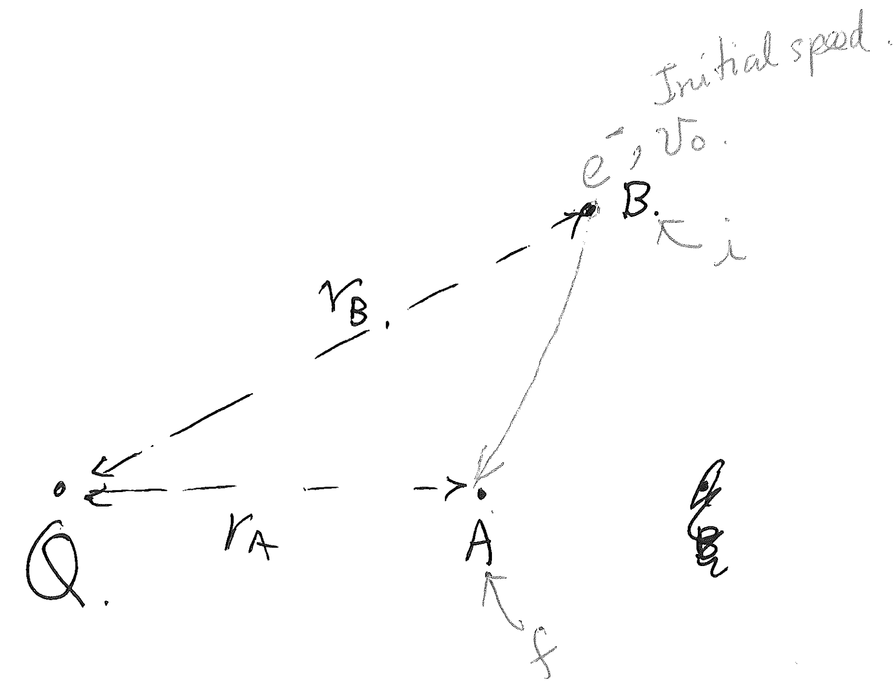
Also a potential at every point in the space.
(scalar)

If potential at $r = \infty$ is 0.

(i.e. $r_i = 0$).

$r_f \rightarrow r$.

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}.$$



$$V_A = \frac{Q}{4\pi\varepsilon_0} \cdot \frac{1}{r_A}$$

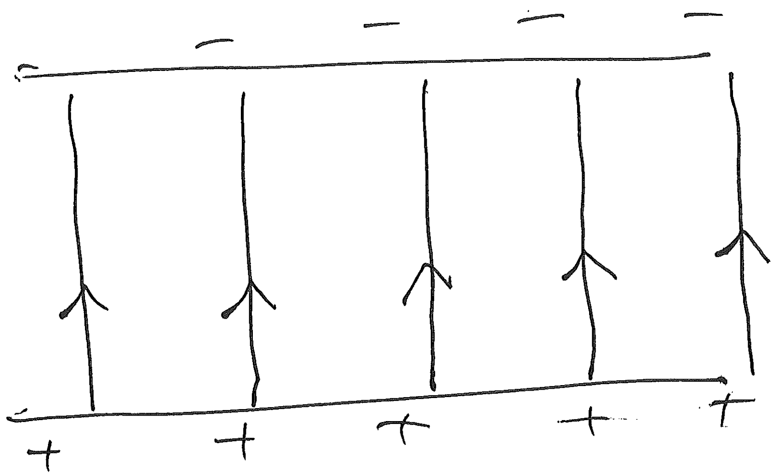
$$V_B = \frac{Q}{4\pi\varepsilon_0} \cdot \frac{1}{r_B}.$$

$$\Delta V = V_A - V_B. = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r_A} - \frac{1}{r_B}\right).$$

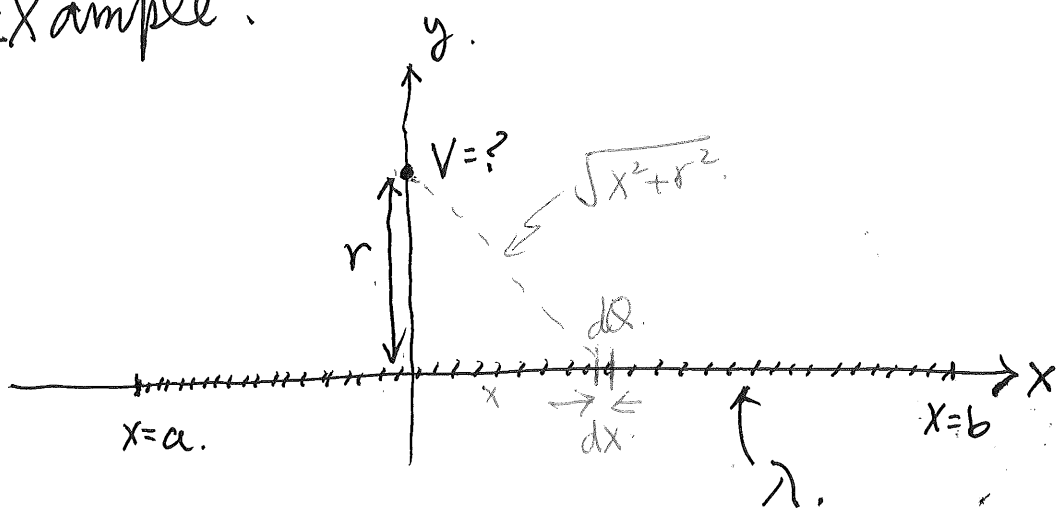
$$\Delta U = q\Delta V = -e\,\Delta V = -\frac{Qe}{4\pi\varepsilon_0}\left(\frac{1}{r_A} - \frac{1}{r_B}\right).$$

$$\Delta K + \Delta U = 0 \Rightarrow -\frac{Qe}{4\pi\varepsilon_0}\left(\frac{1}{r_A} - \frac{1}{r_B}\right) + \left(\frac{1}{2}mv^2 - \frac{1}{2}mv_0^2\right) = 0.$$

$$\Rightarrow v^2 = v_0^2 + \frac{Qe}{2m\pi\varepsilon_0}\left(\frac{1}{r_A} - \frac{1}{r_B}\right).$$



Example.



$$\therefore\ dV = \frac{1}{4\pi\varepsilon_0}\frac{dQ}{\sqrt{x^2+r^2}}.$$

$$V = \int \frac{1}{4\pi\varepsilon_0}\frac{dQ}{\sqrt{x^2+r^2}} = \frac{1}{4\pi\varepsilon_0}\int_a^b \frac{\lambda\,dx}{\sqrt{x^2+r^2}}.$$

$x = r\tan\theta$. ~~and~~ $dx = \dfrac{dr}{\cos^2\theta}$.

((Con't next class!)