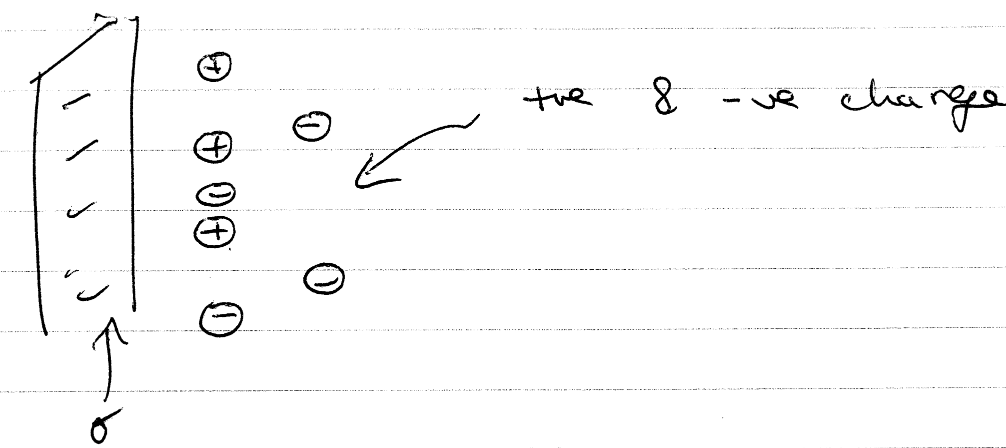
Debye Huckle



- $c_+ = c_\infty e^{-eV(x)/kT}$ $\qquad$ $c_- = c_\infty e^{+eV(x)/kT}$

$$\rho(x) = e\,c_+(x) - e\,c_-(x)$$

so

P-B $\qquad \dfrac{d^2V}{dx^2} = \dfrac{e c_\infty}{\varepsilon}\left(e^{eV(x)/kT} - e^{-eV(x)/kT}\right)$

- for small $eV(x)$ ← small potentials < 25 meV
  expand exp.

$$\rightarrow \quad \frac{d^2V}{dx^2} = \frac{2e^2 c_\infty}{\varepsilon k_B T} V(x) = \frac{V(x)}{\lambda_D^2}$$

where

$$\lambda_D = \sqrt{\frac{\varepsilon k_B T}{2e^2}} \equiv \text{Debye-length}$$

~0.7 nm in H_2O
with $\varepsilon \sim 80$
$c_\infty \sim 200$ mM for K^+
in cell

Now

$$V(x) = Ae^{-x/\lambda_D} + Be^{+x/\lambda_D}$$

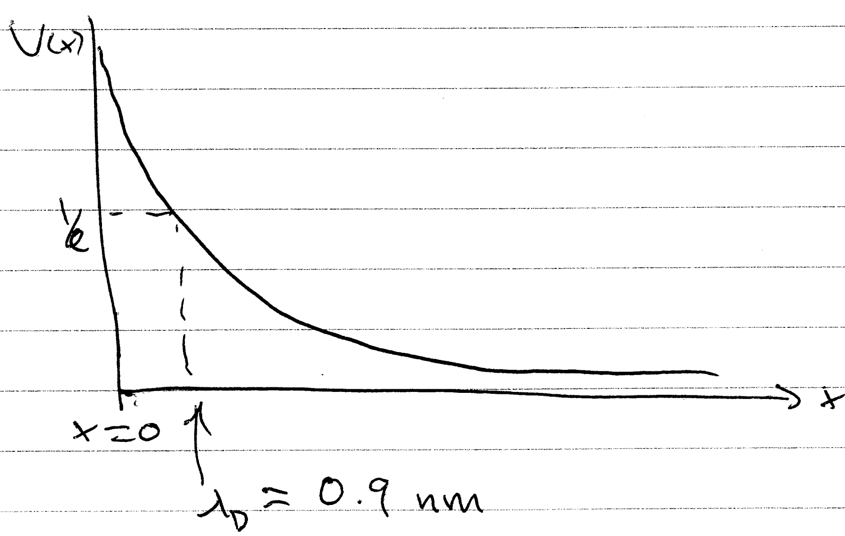
B.C. $V(\infty) = 0 \rightarrow B = 0$

@ $x=0$, $E(0) = \dfrac{\sigma}{\varepsilon} = -\dfrac{dV}{dx}\bigg|_{x=0}$

$$\Rightarrow A = \frac{\sigma\lambda_D}{\varepsilon}$$

so

$$V(x) = \frac{\sigma\lambda_D}{\varepsilon} e^{-x/\lambda_D} \leftarrow \text{screened potential}$$



so for $x > \lambda_D$, charge is effectively screened and $V = 0$.