## [pex4] Electric potential between charged plates immersed in electrolyte

Consider two conducting plates with uniform charge densities  $\sigma_A$  and  $\sigma_B$  positioned as shown. (a) Solve the linearized Poisson-Boltzmann equation,

$$\frac{d^2\psi}{dx^2} - \kappa^2\psi = 0 \quad \kappa^2 = \frac{2e_0^2n_0}{k_{\rm B}T\epsilon},\tag{1}$$

with boundary conditions  $\psi(0) = \psi_{\rm A}$ ,  $\psi(h) = \psi_{\rm B}$ , using the ansatz  $\psi(x) = ae^{-\kappa x} + be^{\kappa x}$ . (b) Use Gauss' law,

$$\psi'(0) = -\frac{\sigma_{\rm A}}{\epsilon}, \quad \psi'(h) = \frac{\sigma_{\rm B}}{\epsilon},$$
(2)

to express the boundary values of  $\psi_{\rm A}, \psi_{\rm B}$  of the potential in terms of the charge densities  $\sigma_{\rm A}, \sigma_{\rm B}$  on the plates and the distance h between the plates. The results of both parts are stated in [pln78].



[adapted from Doi 2013]

## Solution: