Phys338/Homework #8
Due on Monday 21/12/2020

Let us consider a very long rectangular capillary tube of edge length 10nm. This tube is filled with electrolyte solution. If three sides of the tube where held at a potential of 1 V, while the fourth side is held at zero potential. Find the electrostatic potential of the system by solving

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} - k^2 V = 0$$

With the boundary conditions

$$V(0, x) = 1.0, V(10, x) = 1.0, V(0, y) = 1.0 \; and \; V(10, y) = 0$$

The latter is the linear Poisson-Boltzmann equation which can be used to study systems including mobile charges (ions). These mobile charges usually act to screen the electrostatic potential in the system.

1) Solve the problem by writing your code or modifying the provided Poisson equation solver code for different inverse screening lengths (k)

   a. $k = 0$

   b. $k = 0.001$

   c. $k = 0.01$

   d. $k = 0.1$

2) Discuss your result by noticing what happens as the screening length $\lambda = \frac{1}{k}$ becomes smaller.