Exercises 3

1. Following the procedure in Chapter 4.1.2, solve the time dependent problem for an initially loaded membrane, i.e. use the initial condition $c(x,0) = c_0$. Draw a picture analogous to Fig. 4.5. What is the value of the intercept of the linear part of the curve with the y axis?

2. Derive the Goldman-Hodkin-Katz equation of the membrane potential considering ions K^+, Na^+ and Cl^-. In the extracellular fluid, [Na+] ≈ 0.15 M, [K^+] ≈ 0.03 M, [Cl^-] ≈ 0.15 M, and in the intracellular fluid, [Na+] ≈ 0.03 M, [K^+] ≈ 0.15 M, [Cl^-] ≈ 0.15 M. $D_{Na^+} = 0.66 \cdot D_{Cl^-} = 0.68 \cdot D_{K^+}$. Calculate the value of the membrane potential.

3. Textbook problem 3.5.

4. The solutions a) QCl–NaCl and b) NaP–NaCl are in equilibrium with an ideal cation exchange membrane. Q^+ and P^- are so large in size that they cannot enter the membrane. How do they affect the Donnan potential?

5. Write a script in, e.g. Matlab or Python that calculates the Donnan potential in a ternary KCl-$CaCl_2$ system. Set the membrane concentration $X = 3.0$ M, [KCl] = 0.01 M and vary the $CaCl_2$ concentration between 0 and 0.1 M. Plot the Donnan potential and the ionic concentrations in the membrane as a function of the $CaCl_2$ concentration. Excel solver can also be used to solve the problem.