Exercise 3.1.

Consider a local concentration of 0,7 [mol/dm^3] which drops by 15% over a distance of 1[cm]. Assuming that diffusion coefficient is $7 \cdot 10^{-6}$ [cm^2/s] (typical value for fluids), calculate **atomic and molar** fluxes.

Exercise 3.2. Nernst-Planck equation for diffusion flux has a following form:

$$J_i^{diff} = B_i c_i \vec{F_i}$$

Using Nernst-Einstein relation express diffusion flux in a form analogues to Fick's law (one dimensional case) for:

a) Ideal solution (activity f_i=1)
b) Non-ideal solution (activity $f_i \neq 1$)

Assume, that the only force is the gradient of chemical potential, which potential could be expressed as:

$$\mu_i = \mu_i^0 + RT \ln f_i n_i$$

Exercise 3.3. Calculate the flux, knowing that potentials are following functions of space (2D: x, y):

$$\mu^{chem} = 2x^3 + sinyx$$

$$\mu^{mech} = 5xy^{\frac{3}{2}} + \cos 2xy$$

$$\mu^{elec} = 2e^{x^2}$$

Exercise 3.4. Consider a diffusion in a binary A-B system (n_A+n_B=1). Knowing, that the Gibbs-Duhem relation is fulfilled :

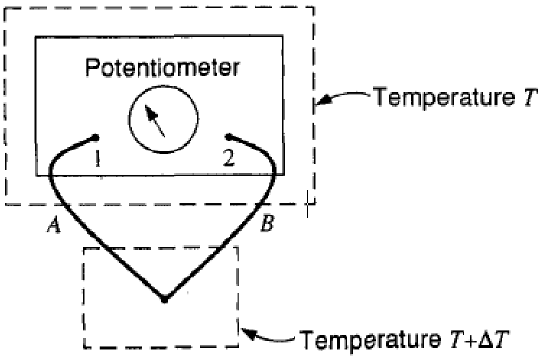
$$\sum_i^2 n_i \nabla \mu_i = 0$$

a) write both fluxes as a functions of conjugate forces only ($J_i = J_i(-\nabla \mu_i)$)

b) wind the value of diffusion coefficients knowing, that the Fick's 1st law has a form $J_i = -D_i \nabla n_i$ and chemical potential is given by:

$$\mu_i = \mu_i^0 + kT \ln n_i$$

Exercise 3.5. A common device used to measure temperature is the thermocouple. Wires of metals A and B are connected with their common junction at the temperature *T+ΔT* and the opposite ends are connected to the terminals of a potentiometer maintained at temperature *T.* The potentiometer measures voltage across terminals under conditions where no electric current is flowing. This voltage is then a measure of ΔT. Explain this effect (known as Seebeck effect) using Onsager's fluxes. **Hint**: $F_Q - \frac{1}{T}\frac{dT}{dx}$ and $F_q = -\frac{d\phi}{dx}$



Exercise 3.6 Find the electric current in terms of the electric field $E = -d\phi/dx$, in a system where there is no transport of heat and mass (J=Q=0). What important conclusions can be seen? **Hint:** Use set of equations from the example 3.1., find thermal and mass thermodynamic forces as a function of electric field.