Summary

What | Why | What amount

Type of interaction	Transported (extensive) quantity	Driving force (gradient)	Intensive quantity	Flux
Electrostatic	q	$-\frac{\Delta\varphi}{\Delta l}$	φ	$J_q = -\sigma\frac{\Delta\varphi}{\Delta l}$
Mechanical	V	$-\frac{\Delta p}{\Delta l}$	p	$J_V = -\frac{r^2}{8\eta}\frac{\Delta p}{\Delta l}$
Chemical	ν (molecules)	$-\frac{\Delta\mu}{\Delta x}$ $(-\frac{\Delta c}{\Delta x})$	μ	$J_\nu = -D\frac{\Delta c}{\Delta x}$

Extensive : proportional to the extent of the system (volume, charge, mass..)

Intensive : does not depend on the system size or the amount of material in the system (pressure, electric potential, temperature..)

Summary

Type of interaction	What is transported (extensive)	Driving force Gradient of intesive quantity	Intensive quantity	Flux
Electrostatic	q	$-\frac{\Delta\varphi}{\Delta l}$	φ	$J_q = -\sigma\frac{\Delta\varphi}{\Delta l}$
Mechanical	V	$-\frac{\Delta p}{\Delta l}$	p	$J_V = -\frac{r^2}{8\eta}\frac{\Delta p}{\Delta l}$
Chemical	ν (molecules)	$-\frac{\Delta\mu}{\Delta x}$ $(-\frac{\Delta c}{\Delta x})$	μ	$J_\nu = -D\frac{\Delta c}{\Delta x}$

The transport is due to the inhomogeneity in the special distribution of the intensive quantities.

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Onsager's linear relation: $\boxed{X \sim J}$

$\boxed{X = LJ}$

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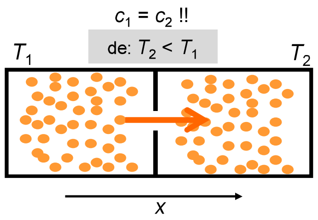
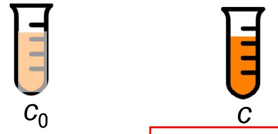
In equlibrium: X= 0

Chemical potential



Thermodiffusion - responses to the force of a temperature gradient

Quantity that includes driving force from both concentration and temperature gardient



μ_0

Chemical normal potential

$$\boxed{\mu = \mu_0 + RT \ln \frac{c}{c_0}}$$

$\left(c_0 = 1 \text{ mol/l, akkor} \quad \mu = \mu_0 + RT \ln c \right)$

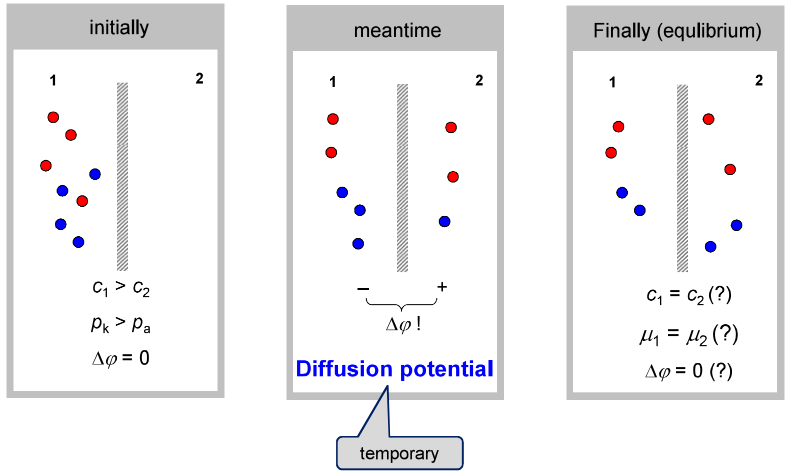
$$[\mu] = \frac{\mathrm{J}}{\mathrm{mol}}$$

Driving force of diffusion : $-\dfrac{\Delta\mu}{\Delta x}$

Diffusion of ions

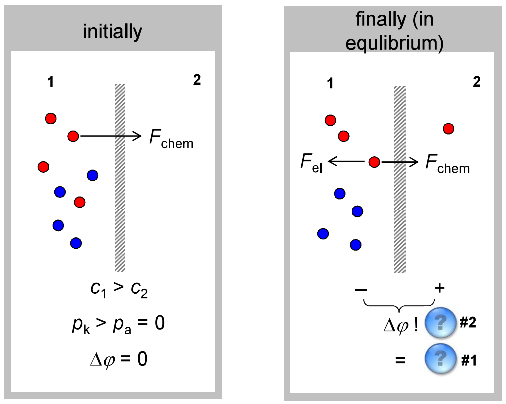
Monovalent ions cations anions

1. $D_c = D_a$



Monovalent ions cations anions

1. $D_c \neq D_a$



#1

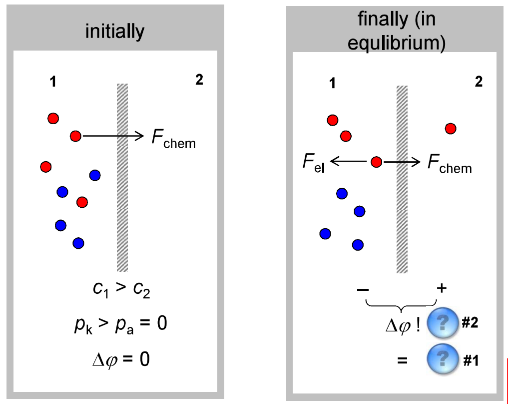
Electrochemical potential (J/mol):

$$\boxed{\mu_e = \mu + \underbrace{ZF \cdot \varphi}_{\text{Electric force of 1 mol ions}}}$$

Electric force of 1 mol ions

$$\boxed{J_v = -D\left(\frac{\Delta c}{\Delta x} + Zc\frac{F}{RT}\frac{\Delta\varphi}{\Delta x}\right)}$$

Monovalent ions cations anions



#1

Electrochemical potential (J/mol):

$$\boxed{\mu_e = \mu + \underbrace{ZF \cdot \varphi}_{\text{Electric force of 1 mol ions}}}$$

Electric force of 1 mol ions

Nernst-equation:

$$\boxed{\Delta\varphi = \varphi_2 - \varphi_1 = -\frac{RT}{F}\ln\frac{c_2}{c_1}}$$

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Chemical	ν (molecules)	$-\frac{\Delta\mu}{\Delta x}$ $(-\frac{\Delta c}{\Delta x})$	μ	$J_\nu = -D\frac{\Delta c}{\Delta x}$
Electro-chemical	ν (ions)	$-\frac{\Delta\mu_e}{\Delta x}$	μ_e	$J_\nu = -D(\frac{\Delta c}{\Delta x} + Zc\frac{F}{RT}\frac{\Delta\varphi}{\Delta x})$