Last Time: "μ_i is equalized when n_i stops changing. But ~~then~~ how? A: Physicochemical mechanics

PI: $\mu \to \mu_g(x)$ PII: "$J = -U_c \frac{d\mu_g}{dx}$ $\left(U = \frac{1}{f} = \frac{D}{RT}\right)$

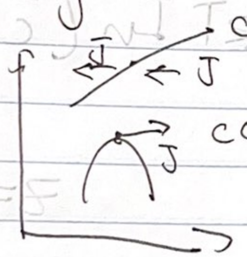
Also always true: continuity $-\frac{\partial J}{\partial x} = \frac{\partial c}{\partial t}$

Deriving transparent / rules laws.

1. Find $\mu_g(x)$ for your system;
2. Use formular from postulate
3. Combine.

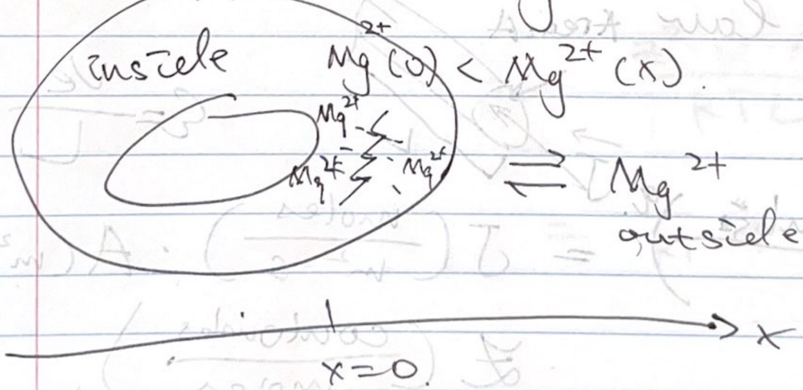
ex: if $\mu_g(x) = \mu^{(0)} + RT\ln(x) \Rightarrow \frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial x^2}$.

Fick's law.



Today: Any "law" you want, Part I.

ex: steady-state Mg^{2+} conc. in a cell.



Mg^{2+} binds to RNA:

$\mu_g(x) = \mu^{(0)}(x) + RT\ln c(x)$.

$[RNA]_{cell} > [RNA]_{outside}$.

In steady-state. $J_{Mg^{2+}} \approx 0$.

" i " = $J_{Mg^{2+}}$ ...

$$\Rightarrow J = \frac{d\mu_g}{dx} = \frac{\partial \mu^{(0)}}{\partial x} + RT\frac{\partial \ln c}{\partial x}$$

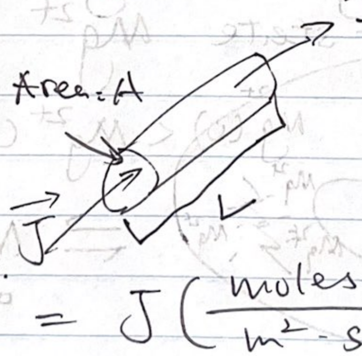
$$\Rightarrow d\mu^{(0)} = -RT\, d\ln c, \quad \left(\int \frac{\partial \mu^{(0)}}{\partial x} dx = -RT \int \frac{\partial \ln c}{\partial x}\right)$$

$$\Rightarrow \int_{\mu^{(0)}(x=0)}^{\mu^{(0)}(x)} d\mu^{(0)} = -RT \int_{c(x=0)}^{c(x)} d\ln c \qquad \ln c(x) - \ln c(0) = \ln\left(\frac{c(x)}{c(0)}\right)$$

$$\Rightarrow \underbrace{\mu^{(0)}(x) - \mu^{(0)}(0)}_{\Delta\mu} = -RT \ln\left(\frac{c(x)}{c(0)}\right)$$

$$\Rightarrow c(x) = c(0)\, \underbrace{e^{-\frac{\Delta\mu}{RT}}}_{\text{Boltzmann factor}} \qquad Z = e^{-\frac{E}{RT}}$$

ex: Ohm's law



$$\mathcal{E} = \frac{V_e}{L}$$

Sys: $I\left(\frac{\text{Colombs}}{s}\right) = J\left(\frac{\text{moles}}{m^2 \cdot s}\right) \cdot A(m^2)$

$$Z\left(\frac{\text{coulombs}}{\text{moles}}\right)$$

$$= V_{drift} \cdot c \cdot A \cdot Z$$

$$v_{drift} = \frac{z\cdot\mathcal{E}}{\gamma} = z\cdot U\cdot\mathcal{E} = z\cdot\frac{D}{RT}\cdot\mathcal{E}$$

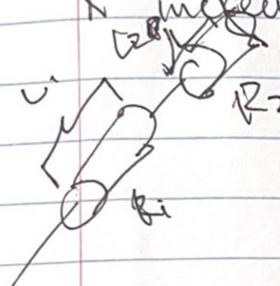
Combine:

$$I = z\frac{D}{RT}\cdot\underbrace{\mathcal{E}}_{V_c/L}\cdot A\cdot z = \left(z^2\frac{D}{RT}\cdot\frac{A}{L}\right)\cdot V_c$$

$$= 1/R.$$

$$I = \frac{V_c}{R} \qquad R = \frac{RT\cdot L}{z^2 D\cdot A}.$$

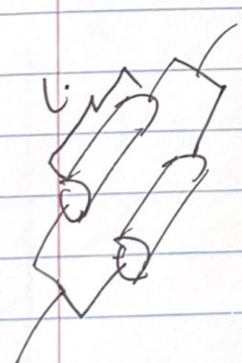
R increases with temperature.



$$R = \frac{RT(L_1+L_2)}{z^2 D\cdot A}$$

$$= \frac{RTL_1}{z^2 D\cdot A} + \frac{RTL_2}{z^2 D\cdot A}$$

$$= R_1 + R_2 \quad (\text{"Series"})$$



$$\frac{1}{R} = \frac{z^2\cdot D\cdot(A_1+A_2)}{RTL}$$

$$\frac{1}{R} = \frac{z^2\cdot D\cdot A_1}{RTL} + \frac{z^2\cdot D\cdot A_2}{RTL}$$

$$= \frac{1}{R_1} + \frac{1}{R_2}. \quad (\text{"Parallel"})$$