

University of M'sila			2 St year CT-NLS
Faculty of Sciences/ CT-NLS			Duration: 1h30 min
Examination of biophysics 2023/2024			
Nom:	First name:	Gr:	Note:

Exercise 1

A bottle of sulfuric acid (H_2SO_4) supports the following indications: $\rho = 1.83 \text{ g/cm}^3$, the mass percentage of sulfuric acid is 96% and its molar mass is 98.08 g/mol.

1. Calculate the ponderal, molar, and molal concentration of this solution.

Exercise 2

One litre of an aqueous solution contains:

5.85 g NaCl, 3.28 g PO_4Na_3 , 9 g glucose, 0.6 g urea. It is supposed that NaCl and PO_4Na_3 are completely dissociated.

Calculate the molarity, osmolarity, ionic, and equivalent concentration of the solution.

The molar masses of NaCl=58.5, PO_4Na_3 =164, glucose=180, and urea=60 g/mol.

Exercise 3

Two compartments A and B are separated by a membrane permeable to glucose molecules with a $\Delta x = 0.1 \text{ mm}$. Compartments A and B contain glucose solutions at concentrations of 36 g/l and 18 g/l, respectively. It is supposed that glucose molecules are spherical with a radius $r = 3 \text{ \AA}$. The viscosity coefficient of glucose is $\eta = 10^{-3} \text{ poiseuille}$, and its molar mass is 180 g/mol.

1. Calculate the initial mass and molar flux of glucose diffusion at 25 and 0 °C.

Exercise 4

Consider a hemoglobin solution with a concentration of 10^{-4} mol/l which diffuses through a membrane of diffusing surface 20 cm^2 up to a concentration of $1.4 \cdot 10^{-4} \text{ mol/l}$. The diffusion coefficient of hemoglobin as $D = 6.9 \cdot 10^{-7} \text{ cm}^2/\text{s}$ and its molar mass as $M = 68 \cdot 10^3 \text{ g/mol}$.

1. Calculate the mass of hemoglobin that has moved 5cm during 1 min in g.

Exam correction

Exercise 1

1L the solution is a solution $m = \rho V = 1830g$

$$m(H_2SO_4) = \frac{1830 \times 96}{100} = 1757g$$

$$C_p = \frac{1757}{1} = 1757g/L$$

$$C(H_2SO_4) = \frac{1757}{98.08 \times 1} = 17.9 \text{ mol/l}$$

$$C(H_2SO_4) = \frac{1757}{98.08 \times 1} = 17.9 \text{ mol/l}$$

$$C_{ml} = \frac{\frac{1757}{98.08 \times 1}}{1830 - 1757} = 0.24 \text{ mol/g}$$

Exercise 2

Substance	Cp(g/l)	C(mol/l)	C _m (mosmol/l)	C ⁱ (iong/l)	Ceq(meq/l)
NaCl	5.58	0.1	200	0.2	200
Po ₄ Na ₃	3.28	0.02	80	0.8	120
Glucose	9	0.05	50	0	0
Urea	0.6	0.01	10	0	0
Solution	18.46	0.18	340	0.28	320

Exercise 3

1. Calculation of mass flow

$$\phi_{mass} = \frac{1}{S} \frac{dm}{dt} = -D \frac{\Delta C_p}{\Delta x}$$

A diffusion is from C_{pt}^A to C_{pt}^B therefore

$$\frac{\Delta C_p}{\Delta x} = \frac{C_t^B(t=0) - C_t^A(t=0)}{\Delta x}$$

$$D = \frac{K_B T}{6\pi\eta r}$$

$$\phi_{mass}(\text{initial}) = \frac{1}{S} \frac{dm}{dt} = -\left(\frac{K_B T}{6\pi\eta r}\right) \frac{C_{pt}^B(t=0) - C_{pt}^A(t=0)}{\Delta x}$$

- For (T=0 °C):

$$\phi_{mass}(\text{initial}) = -\left(\frac{1.38 \times 10^{-23}(0 + 273)}{6 \times \pi \times 10^{-3} \times 3 \times 10^{-10}}\right) \left(\frac{(18 - 36)10^3}{0.1 \times 10^{-3}}\right) = 0.1199 \text{ g/s}$$

- For (T=25°C):

$$\phi_{mass}(\text{initial}) = -\left(\frac{1.38 \times 10^{-23}(25 + 273)}{6 \times \pi \times 10^{-3} \times 3 \times 10^{-10}}\right) \left(\frac{(18 - 36)10^3}{0.1 \times 10^{-3}}\right) = 0.1309 \text{ g/s}$$

1. Calculation of molar flow

$$\phi_{molar} = \frac{1}{S} \frac{dn}{dt} = -D \frac{\Delta C}{\Delta x}$$

$$\phi_{molar}(\text{initial}) = \frac{1}{S} \frac{dn}{dt} = -\left(\frac{K_B T}{6\pi\eta r}\right) \frac{C_{pt}^B(t=0) - C_{pt}^A(t=25)}{\Delta x}$$

For (T=0°C)

$$\phi_{molar}(\text{initial}) = -\left(\frac{1.38 \times 10^{-23}(0 + 273)}{6 \times \pi \times 10^{-3} \times 3 \times 10^{-10}}\right) \left(\frac{(18 - 36)10^3}{0.1 \times 10^{-3} \times 180}\right) = 6.6 \times 10^{-4} \text{ mol/s}$$

For (T=25°C)

$$\phi_{molar}(\text{initial}) = -\left(\frac{1.38 \times 10^{-23}(25+273)}{6 \times \pi \times 10^{-3} \times 3 \times 10^{-10}}\right) \left(\frac{(18-36)10^3}{0.1 \times 10^{-3} \times 180}\right) = 7.27 \times 10^{-4} \text{ mol/s}$$

Exercise 4

Calculation of mass flow

$$\phi_{mass} = \frac{dm}{dt} = -DS \frac{\Delta C_p}{\Delta x}$$

$$\Delta m = -DS \frac{\Delta C_p}{\Delta x} \Delta t$$

The direction of diffusion C_{pt}^I to C_{pt}^II , So:

$$\Delta m = -DS \frac{\Delta C_p}{\Delta x} \Delta t = -DS \frac{(C_{pt}^{II}(t=1\text{min}) - C_{pt}^I(t=1\text{min}))}{\Delta x} \Delta t$$

$$\Delta m = -6.9 \times 10^{-7} \times 20 \times \frac{10^{-3} - 68 \times 10^{-3}}{5} \times 5 \times 60 = 9.6 \times 10^{-7} \text{ g}$$