Homework 7
Summary exercises

Which of the following compounds is bound by a covalent heteropolar bond?

- Hydrochloric acid OK
- Helium
- molecular Hydrogen
- molecular Nitrogen

Which of the following gases has an ideal behaviour at room temperature?

- Methanol
- Hexane
- PCl_5
- di-oxygen OK

Which of the following statements is true when referring to the properties of the osmotic pressure?

- It depends on the temperature; OK
- it does not depend on the dissociation coefficient;
- it does not depend on the the number of ions in solution;
- it depends on the hydrostatic pressure exerted on the solution.

Which of the following statements is true when referring to the equilibrium constant?

- Its numerical value depends on the temperature; OK
- its numerical value does not change with the temperature;
- its numerical value depends on the initial concentration of reagents;
- its numerical value depends on the initial concentration of products.

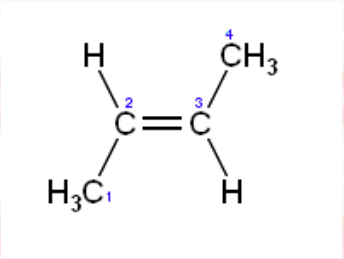
Which of the following compounds is able to hydrolyse water in aqueous solution?

- Sodium acetate OK
- potassium hydroxyl
- ammonium sulfate OK
- sodium chloride

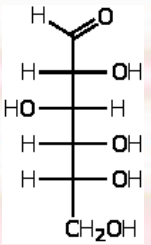
Design the molecular shape (Fisher projections) of the following compounds

Benzene

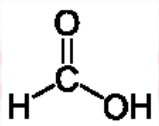
trans-2-butene



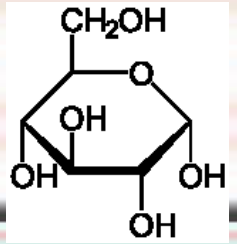
Glucose (open form)



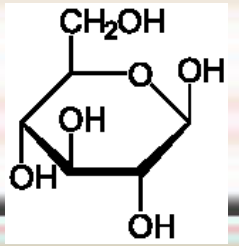
Methanoic acid



α-glucose



β-glucose



Exercise 7

- An aqueous solution has been prepared by dissolving 10 g of an unknown compound in 250 g of water; the osmotic pressure of the solution is 6.5 atm at 25°C. Calculate the formula weight of the compound.

$$\pi = CRT = g \cdot R \cdot T / FW \cdot V$$

250g of H_2O = 250ml

$$FW = g \cdot R \cdot T / V = (10 \cdot 0.082 \cdot 298)/(6.5 \cdot 0.25) = 244.36/1.625 = 150.37 \text{ Da}$$

Exercise 8

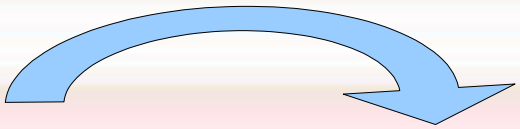
- A buffer solution has been prepared by mixing 200 ml of sodium acetate 0.1M with 200 ml of acetic acid 0.1 M. Calculate the pH of the solution as such and after having added 2ml of NaOH 1M.

Cs = 0.1M
Ca = 0.1M

$$pH = pKa + \log\frac{Cs}{Ca} = 4.74 + \log\frac{0.1}{0.1} = 4.74$$

Eq.salt = N·V = 0.1·0.2 = 0.02
Eq.acid = N·V = 0.1·0.2 = 0.02

eq.base= N·V = $2\cdot10^{-3}\cdot1 = 2\cdot10^{-3}$



1) $CH_3COOH + H_2O \leftrightarrows CH_3COO^- + H_3O^+$ $+ OH^-$

2) $CH_3COONa \rightarrow Na^+ + CH_3COO^- + H_2O \leftrightarrows CH_3COOH + OH^-$

- Therefore: Cs increases and Ca decreases by the same amount of base added to the solution:

$Eq_{(base)} = 2 \cdot 10^{-3}$ eq

We can approximate the volume to remain constant since we are adding 1ml of acid into 1L of solution

Cs = [Eq.s + Eq.b] / V = (0.02+0.002) /0.402 = 0.055 N
Ca = [Eq.a – Eq.b] / V = (0.02-0.002) /0.402 = 0.045 N

$$pH = pKa + \log\frac{Cs}{Ca} = 4.74 + \log\frac{0.055}{0.045} = 4.74 + \log 1.22 = 4.74 + 0.086 = 4.83$$

Exercise 9

- An aqueous solution containing 1g of HNO_2 in 200 ml has a measured pH = 2.14. Calculate the dissociation coefficient (α).

$$\underset{n(1-\alpha)}{HNO_2} \leftrightarrows \underset{n\alpha}{H^+} + \underset{n\alpha}{NO_2^-}$$

$[H^+]=[NO_2^-]= 10^{-pH} = 10^{-2.14} = 7.2\cdot10^{-3}M \rightarrow n_{(diss)} = 1.44\cdot10^{-3}$

$[HNO_2] = Ca = 1/ (47 \cdot 0.2) = 0.106M \rightarrow n_{(tot)} = 0.0213$

$\alpha = n_{diss} / n_{tot} = 1.44 \cdot10^{-3}/0.0213 = 0.068 = 6.8\%$

Or alternatively:

$[H^+]= n\alpha /V = Ca\cdot\alpha \rightarrow \alpha = [H^+] / Ca = 7.2\cdot10^{-3} / 0.106 = 0.068$

Exercise 10

- A solution has been prepared by mixing 150 ml of NaCl 0.05 M with 250 ml of NaCl 0.15 M. Calculate the molar concentration of the final solution and its pH.

$n_1 = C1 \cdot V1 = 0.05 \cdot 0.15 = 7.5 \cdot 10^{-3}$

$n_2 = C2 \cdot V2 = 0.15 \cdot 0.25 = 37.5 \cdot 10^{-3}$

$n_{tot} = n_1 + n_2 = 0.0075 + 0.0375 = 0.045$

$V_{tot} = 0.15 + 0.25 = 0.4$

$C_{tot} = n_{tot} / V_{tot} = 0.045 / 0.4 = 0.11M$

pH = 7.0 this is just a mix of two solutions of a strong salt