LABORATORY 2

ELECTROLYTE DISSOCIATION, pH

1. Calculation of dissociation degree and dissociation constant of weak electrolytes based on pH measurements

Procedure:

Fill 2 measuring vessels with 0.1 M acetic and formic acid solution, and measure pH on pH meter. Calculate dissociation degree (α) and dissociation constant (K) using presented formulas.

$$\alpha = \frac{[H^+]}{C_0} \times 100\ \%$$

$$K = \frac{[H^+]^2}{C_0 - [H^+]} \qquad \text{or} \qquad K = \frac{[H^+]^2}{C_0}$$

After **α** calculation decide if you can use simplified formula for **K** calculation (α < 2%).

Present the results in the table.

Concentration of the solution	pH	$[H^+]$	[undissociated acid]	dissociation degree (α) (%)	dissociation constant (K)
0.1M CH_3COOH					
0.1M HCOOH					

Conclusion: Define the relations between α and K and the strength of electrolytes.

2. Concentration-dependent comparison of dissociation degree of lactic acid and hydrochloric acid

Procedure:

Fill measuring vessels with 0.1 M and 0.001 M solutions of lactic and hydrochloric acids, and measure pH on pH meter. Calculate concentration of H^+ and dissociation degree.

Present the results in the table.

Acid and concentration (C_0)	pH	$[H^+]$	Dissociation degree (%)
0.1 M lactic acid			
0.001 M lactic acid			
0.1 M HCl			
0.001 M HCl			

Conclusions: Answer, how dissociation degree was changed after 100 times increase of concentrations of acids and explain, what is clinical significance of such change in case of lactic acid.

3. The influence of pH on medicines dissociation with aspirin as an example

Acetylsalicylic acid (aspirin) is a weak organic acid with pK_a = 3.5. Only undissociated molecules of aspirin can diffuse from stomach to blood vessels through lipid cell membranes. Whereas dissociated molecules are polar and are retained by cell membranes.

Knowing pH of gastric juice, pH of blood, and pK of acetylsalicylic acid calculate a ratio between dissociated and undissociated form of acid using presented formula.

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

Present the results in the table.

	pH	ratio $[A^-]/[HA]$	% [HA]	% $[A^-]$
gastric juice	1.5			
blood	7.4			

Conclusions: Based on calculations, define, where (in stomach or blood) there will be higher concentration of aspirin. Explain your answer.

Problems

1. Dissociation degree of 0.1 M hydrogen cyanide (HCN) is 0.007%. Count dissociation constant of HCN. (Answer: $K = 4.9 \times 10^{-10}$)
2. Calculate molar concentration of water solution of ammonia ($NH_3 \cdot H_2O$) pH = 8 and α = 0.01 %. (Answer: C_m = 0.01 moles/L)
3. What will be pH change after addition of 1 drop of 2 mol/L HCl solution to 1 L of water (the volume of 1 drop = 0.05 mL). (Answer: pH changes from 7 to 4)
4. 0.11 moles of HCl and 0.01 moles of NaOH were mixed in a final volume of 1 liter of water. Count pH of the solution. (Answer: pH = 1)
5. In 1 mL of gastric juice there are 3 mg of HCl (HCl = 36.5 g/mole). What is pH of gastric juice ? (Answer: pH = 1.09)
6. 40 mL of 0.5 M NaOH, 15 mL of 2 M HCl and 45 mL of water were mixed. Calculate pH of obtained solution. (Answer: pH = 1)
7. There are two acids 0.1 M HCN ($K = 4.9 \times 10^{-10}$) and 0.1 M H_2CO_3 ($K = 4.3 \times 10^{-7}$). Explain (without calculations):
   a. which acid is stronger;
   b. which acid releases more hydrogen ions to the solution;
   c. which acid has higher dissociation degree;
   d. In which solution there is higher concentration of OH^- ions?
8. How many grams of OH^- (17 g/mol) ions there is in 200 mL of the solution with pH 10.5? (Answer: $1.075 \cdot 10^{-3}$ g)

9. Calculate pH of the solution in which concentration of OH^- ions is 100 times higher than H^+ ions. (Answer: pH = 8)
10. Calculate pH of 0.15 M solution of NaOH. (Answer: pH = 13.18)