ELECTROLYTES. HARNESS OF WATER

Experiment 1.
Determination of pH using indicator papers

Laboratory equipment:
- test tubes in rack,

Chemicals:
- $NaNO_3$,
- NH_4Cl,
- $MgCl_2$,
- $AlCl_3$,
- Na_2CO_3,
- Na_2HPO_4.

Pour approximately $1cm^3$ of each solution into a test-tubes. Then wet sequentialy indicator papers with salts and compare the color with universal indicator color scale assesing pH with accurancy 1.

Experiment 2.
Determination of dissociation degree and dissociation constant of aqueous CH_3COOH

Laboratory equipment:
- test tubes in rack,
- pH-meter,
- universal electrode,
- indicator papers,
- beakers

Chemicals:
- 1 M CH_3COOH
- 0,01 M CH_3COOH

Determine the pH of the 0.01 M and 1 M acetic acid solution with an indication papers. Measure the pH of the solutions using a pH meter. Calculate the hydrogen ion concentration corresponding to the values of the pH of both solutions.

Experiment 3.
Ionic Reactions preparation of sparingly soluble salts

Laboratory equipment:
- test tubes in rack,

Chemicals:
- 1M $BaCl_2$
- 1M $Ba(NO_3)_2$
- 1M Na_2SO_4
- 1M H_2SO_4

Pour approximately 1 cm^3 of $BaCl_2$ into two tubes and $1cm^3$ Ba $(NO_3)_2$ to the next two. Add dropwise H_2SO_4 to one tube with $BaCl_2$ and one with $Ba(NO_3)_2$. Analogous deposit precipitates using Na_2SO_4.Write reactions in ionic and molecular form in the appropriate table in a worksheet report.

Experiment 4
Determination of temporary hardness of water

Determination of temporary hardness of water is based on the titration of the water sample with a solution of hydrochloric acid of a known concentration in the presence of the indicator. During titration calcium and magnesium bicarbonates react with hydrochloric acid according to the reactions:

$$Ca(HCO_3)_2 + 2\ HCl = CaCl_2 + 2H_2O + 2CO_2$$

$$Mg(HCO_3)_2 + 2HCl = MgCl_2 + 2H_2O + 2CO_2$$

Change of the indicator’s colour points to the end of the titration.

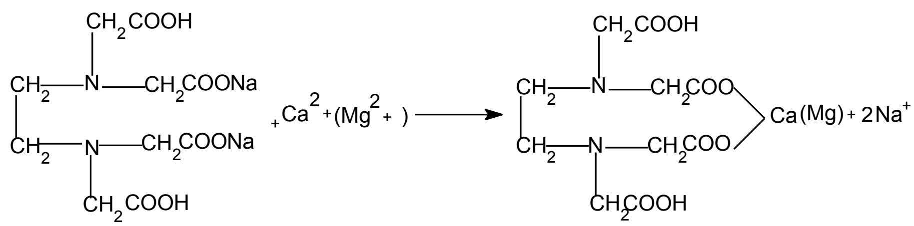
Laboratory equipment:
- 4 conical flasks,
- burette,
- pipette

Chemicals:
- 0.1M HCl,
- indicator (methyl orange)

Measure 50cm^3 of tap water using measuring cylinder. Pour it into a conical flask, add 2 drops of methyl orange. Fill the burette with 0.1 M HCl to the volume marked "0", and titrate water dropwise from a burette until the solution of the colour change from yellow to pink. Read the burette volume of HCl used. Repeat titration. For the calculation take the average of the results.
Perform the same procedure for boiled, distilled and mineral water.

Experiment 5
Determination of total hardness of water with disodium edetate

Determination of total hardness is based on the titration of the water sample containing ammonium buffer (pH~10) solution of disodium EDTA to a known concentration as an indicator of Eriochrome black. In this environment, calcium and magnesium ions, which are responsible for water hardness, react with disodium edetate according to the reaction:



Laboratory equipment:
- conical flasks,
- burette,
- pipette

Chemicals:
- 0.02 M EDTA,
- indicator (Eriochrome black),
- ammonium buffer

In order to be sure observing the end of the titration, it is advisable to use comparative solution: the analyzed water containing the same amount of buffer and indicator. Measure 50 cm^3 of tap water using measuring cylinder to 2 conical flasks, add 1cm^3 of the ammonium buffer with pipette and 5 drops of Eriochrome black indicator. Both flask set next to each other on a white sheet. The first solution is to be treated as a pattern of colour, while the second titrate with 0.02 M EDTA solution until the colour changes from red to blue. Read the burette volume of EDTA solution consumed. Repeated titration. For the calculation take the average of the results.
Perform the same procedure for boiled, distilled and mineral water.

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Experiment 1.
Determination of pH using indicator papers

Salt	pH	hydrolysis reaction	pH range after hydrolysis
$NaNO_3$			
NH_4Cl		$NH_4^+ + Cl^- + H_2O = NH_4OH + H^+ + Cl^-$	pH<7 (acidic)
$MgCl_2$			
$AlCl_3$			
Na_2CO_3			
Na_2HPO_4			

Experiment 2.
Determination of dissociation degree and dissociation constant of aqueous CH_3COOH

concentration of acetic acid	pH (indicator paper)	pH (pH – meter)	concentration of hydrogen ions $[H^+]$	the degree of dissociation α	dissociation constant K
1M					
0,01M					

Calculate α and K using following formulas:

$$\alpha = \frac{n_d}{n_o} \qquad (1)$$

α - the degree of dissociation
n_d – number of moles of dissociating molecules
n_o - overall number of moles of molecules

$$K = \frac{\alpha \cdot C_m}{1-\alpha} \qquad (2)$$

α - the degree of dissociation
K - dissociation constant
C_m - molar concentration of electrolyte

Assumig for weaks electrolytes $1-\alpha \approx 1$ formula (2) can be expressed as:

$$K = \alpha^2 C \qquad (3)$$

Experiment 3.
Ionic Reactions preparation of sparingly soluble salts

Reagents	Reaction in molecular and ionic form
$BaCl_2 + H_2SO_4$	$BaCl_2 + H_2SO_4 = BaSO_4 \downarrow + 2HCl$ $Ba^{2+} + \cancel{2Cl^-} + \cancel{2H^+} + SO_4^{2-} = BaSO_4 \downarrow \cancel{+ 2H^+} \cancel{+ 2Cl^-}$
$Ba(NO_3)_2 + H_2SO_4$	
$BaCl_2 + Na_2SO_4$	
$Ba(NO_3)_2 + Na_2SO_4$	

Experiments 4, 5.
Determination of temporary and permanent hardness of water

type of water	v_{HCl} [cm^3]	temporary hardness [°dH]	v_{EDTA} [cm^3]	general hardness [dGH]	class of water
tap water					
boiled water					
distilled water					
mineral water					

Basing on titration results calculate temporary hardness according to formula (4) and the overall hardness according to the formula (5). The results collectin the table on the report sheet. On the basis of the total hardness qualify tap water, ion-exchange column softened and softened by heat to a grade.

$$H_{temporary} = v_{HCl} \cdot 2.8 \quad [^{o}dH] \qquad (4)$$

$$H_{permanent} = \frac{v_{EDTA} \cdot 0.2 \cdot 1000}{v_w} \quad [dGH] \qquad (5)$$

v_{HCl} - the volume of acid consumed for titration of the water sample [cm^3

v_w - the volume of water taken for the titration [cm^3]

v_{EDTA} - disodium edetate volume consumed for water titration [cm^3]

0.2 - conversion factor

Classify the water due to its hardness according to Table below.

Classification	hardness in dGH/°dH
Soft	0-3.37
Moderately hard	3.38-6.74
Hard	6.75–10.11
Very hard	≥ 10.12