A Test tube experiments

Sodium hydroxide as a precipitating agent

Add few drops of 10 % sodium hydroxide solution to 2 cm^3 of the following solutions. If precipitate is formed, add small excess of sodium hydroxide while you see any changes.

- Adding strong alkali hydroxide to solutions containing cations of transition metals leads to the formation of coloured precipitates, whereas solutions of group 2 metals form white precipitates.

Add NaOH solution slowly until any change occurs.	**Fe^{2+}(aq)**	**Ca^{2+}(aq)**	**Mn^{2+}(aq)**
Observation			
Name and formula of formed poorly soluble compound			
Reaction type			
Reaction			

- Hydroxides such as $Al(OH)_3$, $Zn(OH)_2$, and $Pb(OH)_2$ are amphoteric. They react with excess of sodium hydroxide forming soluble complex salts.

Add NaOH solution slowly until any change occurs.	**Zn^{2+}(aq)**	**Cr^{3+}(aq)**
Observation		
Name and formula of formed poorly soluble compound		
Reaction type		
Reaction		

- In case of ammonium cation, no precipitate is formed in reaction with sodium hydroxide, but when slightly heated, gaseous ammonia is eliminated.

Add NaOH solution slowly until any change occurs.	**NH_4^+(aq)**
Observation	
Reaction	

Ammonia solution

Ammonia, when dissolved in water, is poorly ionized forming ammonium cations and hydroxide anions.

$$NH_3(aq) + H_2O(l) \rightleftarrows NH_4^+(aq) + OH^-(aq)$$

Add few drops of 10 % sodium hydroxide solution to 2 cm^3 of the following solutions. If precipitate is formed, add small excess of sodium hydroxide while you see any changes.

- Most metal cations (except sodium and potassium) react with ammonia solution forming insoluble hydroxides.

Add NH_3 solution slowly until any change occurs.	**Al^{3+}(aq)**	**Mn^{2+}(aq)**
Observation		
Name and formula of formed poorly soluble compound		
Reaction type		
Reaction		

- Some metal cations, such as Cu^{2+} a Zn^{2+}, react with ammonia forming complexes. Their hydroxides are soluble in excess of ammonia.

❶ Add NH_3 solution slowly until any change occurs. ❷ Add excess of NH_3 solution to the mixture in the test tube 1.	**Cu^{2+}(aq)**	**Cr^{3+}(aq)**
Observation	❶	❶
	❷	❷
Name and formula of formed poorly soluble compound		
Reaction type		
Reaction		

B Reactions of metals (Zn, Fe, Cu, Pb) with acids

Chemicals

- zinc, Zn, granules
- iron, Fe, wire
- copper, Cu, wire
- lead, Pb, thin sheet
- sulphuric acid, $w(H_2SO_4) = 0.96$
- nitric acid, $w(HNO_3) = 0.63$
- hydrochloric acid, $w(HCl) = 0.36$
- sulphuric acid, diluted 1 : 2
- nitric acid, diluted 1 : 2
- hydrochloric acid, diluted 1 : 1

Procedure

We will prepare a stand for test tubes and 24 test tubes, which we will divide into 4 groups of six tubes. We put pieces of zinc in the first group of test tubes, pieces of iron in the second group, pieces of copper in the third group and pieces of lead in the fourth group. Then pour 2 cm^3 of one acid solution into the 1st to 6th test tubes in each group in the following order: 96% H_2SO_4, H_2SO_4 (1 : 2), 63% HNO_3, HNO_3 (1 : 2), 36% HCl, HCl (1 : 1). Heat the tubes containing copper and lead slightly.

	Zn	**Fe**	**Cu**	**Pb**
96% H_2SO_4				
H_2SO_4 (1 : 2)				
63% HNO_3				
HNO_3 (1 : 2)				
36% HCl				
HCl (1 : 1)				

Warning: We are working in a hood!

We observe the escape of gases and colour changes that occur during redox events. We will write down all observations, equations of ongoing chemical reactions in the state form in the laboratory diary and clarify their progress.

metal	oxidation equation	reduction
Zn $E^{\varnothing}(Zn^{2+}\vert Zn)$ = −0.762 V	$Zn(s) + H_2SO_4(conc.) \rightarrow ZnSO_4(aq) + SO_2(g) + 2\ H_2O(l)$	$S^{VI} \rightarrow S^{IV}$
	$Zn(s) + H_2SO_4(aq, diluted) \rightarrow ZnSO_4(aq) + H_2(g)$	$H^{I} \rightarrow H^{0}$
	$Zn(s) + 4\ HNO_3(conc.) \rightarrow Zn(NO_3)_2(aq) + 2\ NO_2(g) + 2\ H_2O(l)$	$N^{V} \rightarrow N^{IV}$
	$4\ Zn(s) + 10\ HNO_3(aq, diluted) \rightarrow 4\ Zn(NO_3)_2(aq) + NH_4NO_3(aq) + 3\ H_2O(l)$	$N^{V} \rightarrow N^{-III}$
	$Zn(s) + 2\ HCl(aq, conc.) \rightarrow ZnCl_2(aq) + H_2(g)$	$H^{I} \rightarrow H^{0}$
	$Zn(s) + 2\ HCl(aq, diluted) \rightarrow ZnCl_2(aq) + H_2(g)$	$H^{I} \rightarrow H^{0}$
Fe $E^{\varnothing}(Fe^{2+}\vert Fe)$ = −0.447 V	$Fe(s) + H_2SO_4(conc.) \rightarrow$ passivation	–
	$Fe(s) + H_2SO_4(aq, diluted) \rightarrow FeSO_4(aq) + H_2(g)$	$H^{I} \rightarrow H^{0}$
	$Fe(s) + 6\ HNO_3(conc.) \rightarrow Fe(NO_3)_3(aq) + 3\ NO_2(g) + 3\ H_2O(l)$ ❶	$N^{V} \rightarrow N^{IV}$
	$3\ Fe(s) + 8\ HNO_3(aq, diluted) \xrightarrow{\Delta T} 3\ Fe(NO_3)_2(aq) + 2\ NO(g) + 4\ H_2O(l)$ ❷	$N^{V} \rightarrow N^{II}$
	$Fe(s) + 10\ HNO_3(aq, very\ diluted) \rightarrow 4\ Fe(NO_3)_2(aq) + NH_4NO_3(aq) + 3\ H_2O(l)$	$N^{V} \rightarrow N^{-III}$
	$Fe(s) + 2\ HCl(aq, conc.) \rightarrow FeCl_2(aq) + H_2(g)$	$H^{I} \rightarrow H^{0}$
	$Fe(s) + 2\ HCl(aq, diluted) \rightarrow FeCl_2(aq) + H_2(g)$	$H^{I} \rightarrow H^{0}$
Pb $E^{\varnothing}(Pb^{2+}\vert Pb)$ = −0.126 V	$Pb(s) + 2\ H_2SO_4(conc.) \xrightarrow{\Delta T} PbSO_4(s) + SO_2(g) + 2\ H_2O(l)$	$S^{VI} \rightarrow S^{IV}$
	$Pb(s) + H_2SO_4(aq, diluted) \rightarrow$ no reaction	–
	$Pb(s) + 4\ HNO_3(conc.) \xrightarrow{\Delta T} Pb(NO_3)_2(aq) + 2\ NO_2(g) + 2\ H_2O(l)$	$N^{V} \rightarrow N^{IV}$
	$3\ Pb(s) + 8\ HNO_3(aq, diluted) \xrightarrow{\Delta T} 3\ Pb(NO_3)_2(aq) + 2\ NO(g) + 4\ H_2O(l)$ ❷	$N^{V} \rightarrow N^{II}$
	$Pb(s) + 2\ HCl(aq, conc.) \xrightarrow{\Delta T} PbCl_2(s) + H_2(g)$	$H^{I} \rightarrow H^{0}$
	$Pb(s) + 2\ HCl(aq, diluted) \xrightarrow{\Delta T} PbCl_2(s) + H_2(g)$	$H^{I} \rightarrow H^{0}$
Cu $E^{\varnothing}(Cu^{2+}\vert Cu)$ = 0.342 V	$Cu(s) + H_2SO_4(conc.) \xrightarrow{\Delta T} CuO(s) + SO_2(g) + H_2O(l)$ ❸	$S^{VI} \rightarrow S^{IV}$
	$Cu(s) + H_2SO_4(aq, diluted) \rightarrow$ no reaction	–
	$Cu(s) + 4\ HNO_3(conc.) \rightarrow Cu(NO_3)_2(aq) + 2\ NO_2(g) + 2\ H_2O(l)$	$N^{V} \rightarrow N^{IV}$
	$3\ Cu(s) + 8\ HNO_3(aq, diluted) \rightarrow 3\ Cu(NO_3)_2(aq) + 2\ NO(g) + 4\ H_2O(l)$ ❷	$N^{V} \rightarrow N^{II}$
	$Cu(s) + HCl(conc.) \rightarrow$ no reaction	–
	$Cu(s) + HCl(aq, diluted) \rightarrow$ no reaction	–

❶ Strong oxidative influence of HNO_3 causes the oxidation of metallic iron up to Fe^{III}. Forming $Fe(NO_3)_3$ has pale brown colour in comparison to pale green colour of $Fe(NO_3)_2$.

❷ In the reaction with diluted HNO_3 the colourless gaseous NO is eliminated, but it is immediately oxidized with aerial oxygen to the red-orange gaseous NO_2, according to the equation: $2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$. Therefore, the red-orange NO_2 is the final product of the reaction.

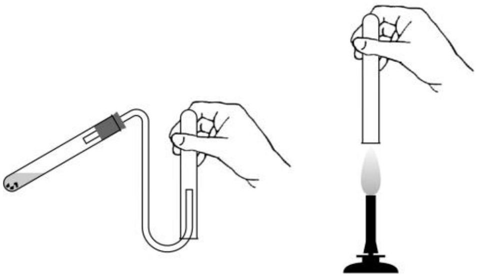
❸ Water forming during the reaction dilutes the concentrated H_2SO_4, therefore the reaction starts to slow down. Copper does not react with the diluted H_2SO_4. On the other hand, insoluble black CuO reacts only with diluted, but not with concentrated H_2SO_4: $CuO(s) + H_2SO_4(aq, diluted) \rightarrow CuSO_4(aq) + H_2O(l)$. Therefore, outwardly we can see the slightly blue solution of $CuSO_4$, which is a product of the subsequent reaction.

C Reaction of calcium with water

Chemicals

- calcium, Ca, small pieces

Procedure



Collection and burning of hydrogen

Pour about 10 cm^3 of distilled water into the test tube and add a bit of calcium. We are observing the evolution of hydrogen, created by the reaction of calcium with water. We capture the hydrogen in a dry test tube turned upside down, close it with our thumb, bring it closer to the flame and release its opening. If there is an explosive mixture of hydrogen and oxygen in the test tube, then the combustion of the mixture is accompanied by a loud "barking". We write down the observation in the laboratory diary.
Write the chemical equation in a state form!

D Reactions of aluminium with sulphuric acid and sodium hydroxide.

Chemicals

- aluminium, Al, wire of thin sheet
- sulphuric acid, $c(H_2SO_4) = 2$ mol dm^{-3}
- sodium hydroxide, $c(NaOH) = 2$ mol dm^{-3}

Procedure

Pour 2 cm^3 of 2M sulphuric acid to a test tube and 2 cm^3 of 2M sodium hydroxide to another test tube. Add a piece of aluminium to both test tubes. Aluminium, as an amphoteric metal, reacts with both acid and hydroxide forming gaseous hydrogen. Analogous to the previous experiment, collect the hydrogen in a dry test tube and try to burn it with a burner.
Write the chemical equation in a state form!

E Oxidation of metal hydroxides $M(OH)_2$ (M = Co, Fe, Mn) with hydrogen peroxide

Transition metals form coloured compounds and their reaction are followed by colour changes. These specific colour changes could be used as an evidence of particular cations M^{2+} (M = Co, Fe, Mn) in their reactions with alkali hydroxide and the next oxidations with hydrogen peroxide.

$$M^{2+}(aq) + 2\,OH^{-}(aq) \longrightarrow M(OH)_2(s)$$

$$2\,M(OH)_2(s) + H_2O_2(aq) \longrightarrow 2\,MO(OH)(s) + 2\,H_2O(l)$$

Chemicals

- cobalt(II) nitrate, $c(Co(NO_3)_2) = 0.10$ mol dm^{-3}
- iron(II) sulphate, $c(FeSO_4) = 0.10$ mol dm^{-3}
- manganese(II) sulphate, $c(MnSO_4) = 0.10$ mol dm^{-3}
- potassium hydroxide, $c(KOH) = 0.10$ mol dm^{-3}
- hydrogen peroxide, $w(H_2O_2) = 0.030$

Procedure

Prepare three test tubes containing 10 cm^3 of solution of particular salts – $Co(NO_3)_2$, $FeSO_4$ and $MnSO_4$.

❶ Add 10 cm^3 of solution of KOH. Do not stir the content of the test tubes! Coloured precipitates of hydroxides $M(OH)_2$ should be visible.
Write the chemical equation in a state form!

❷ Add 1.0 cm^3 of solution of H_2O_2. to each test tube. Do not stir the content of the test tubes! Coloured precipitates of hydroxide-oxides MO(OH) should be visible.
Write the chemical equation in a state form!

	original solution	**after adding KOH**	**after adiing H_2O_2**
$Co(NO_3)_2$			
$FeSO_4$			
$MnSO_4$			

F Reakcie zlúčenín mangánu s oxidačnými číslami II – VII

Manganese is a transition element that forms a large number of strongly coloured compounds. Manganese atoms occur in compounds in oxidation numbers –III to VII, with the common oxidation numbers of manganese being II, IV and VII. Manganese compounds in oxidation state VII are very strong oxidizing agents in both acidic and basic environments. Potassium permanganate in an acidic environment oxidizes ferrous salts to ferrous, arsenic oxide to arsenate, hydrogen peroxide to oxygen, nitrites to nitrates and oxalic acid to carbon dioxide, which is used in analytical chemistry (manganometry).
Permanganate oxidizes hydrogen peroxide in an alkaline environment to oxygen, while it is reduced to green permanganate,

$$2\ MnO_4^-(aq) + 2\ OH^-(aq) + H_2O_2(aq) \longrightarrow 2\ MnO_4^{2-}(aq) + O_2(g) + 2\ H_2O(l)$$

or in a neutral or weakly alkaline environment, up to brown manganese dioxide.

$$2\ MnO_4^-(aq) + 3\ H_2O_2(aq) \longrightarrow 2\ MnO_2(s) + 3\ O_2(g) + 2\ H_2O(l) + 2\ OH^-(aq)$$

Permanganate is reduced to blue hypomanganate in a strongly alkaline environment.

$$2\ MnO_4^-(aq) + 4\ OH^-(aq) \longrightarrow 2\ MnO_4^{3-}(aq) + O_2(g) + 2\ H_2O(l)$$

Hydrogen peroxide in an acidic environment reduces permanganate to a pink manganese(III) salt.

$$MnO_4^-(aq) + 4\ H_3O^+(aq) + 2\ H_2O_2(aq) \longrightarrow Mn^{3+}(aq) + 2\ O_2(g) + 8\ H_2O(l)$$

Potassium permanganate is reduced to pale pink manganese(II) sulphate with a very dilute solution of hydrogen peroxide, acidified with a dilute acid solution, in the presence of a small amount of $MnSO_4$.

$$2\ KMnO_4(aq) + 5\ H_2O_2(aq) + 3\ H_2SO_4(aq) \longrightarrow K_2SO_4(aq) + 2\ MnSO_4(aq) + 5\ O_2(g) + 8\ H_2O(l)$$

Chemicals

- potassium permanganate solution, $c(KMnO_4) = 3.5 \cdot 10^{-3}$ mol dm^{-3}
- manganese(II) chloride solution, $w(MnCl_2) = 0.10$
- sulphuric acid solution, $w(H_2SO_4) = 0.96$
- hydrogen peroxide solution, $w(H_2O_2) = 0.060$
- sodium hydroxide solution, $c(NaOH) = 6.0$ mol dm^{-3}
- sodium hydroxide solution, $w(NaOH) = 0.50$

Procedure

- We prepare 6 test tubes, which we label A, B, C, D, E and F. We pour 10 cm^3 of $KMnO_4$ solution into test tubes A to E. The purple solution in test tube A, which represents the compound Mn^{VII}, is kept for comparison.
- Pour 10 cm^3 of manganese(II) chloride solution into test tube F and keep it for comparison. The light pink colour of the solution indicates the presence of $[Mn(H_2O)_6]^{2+}$ cations.
- Add 5 drops of sodium hydroxide solution with $c(NaOH) = 6.0$ mol dm^{-3} to test tube B and mix the solution in the test tube. Then, while stirring, drop by drop a 6% solution of hydrogen peroxide. After adding about 2 – 3 drops of hydrogen peroxide solution, we get a green solution.
- Add 9 cm^3 of 50% sodium hydroxide solution to test tube C and mix the solution in the test tube. Then carefully add 1 – 2 drops of 50% sodium hydroxide solution and mix the solution. We get a dark blue solution.
- Add 5 drops of sodium hydroxide solution with $c(NaOH) = 6.0$ mol dm^{-3} to test tube D and mix the obtained solution. Then we carefully add about 5 drops of 6% hydrogen peroxide solution, mixing the solution after each drop. A brown precipitate is separated from the solution.
- Add one drop of concentrated sulphuric acid to test tube E and mix the solution. Then add another 1 – 2 drops of 6% hydrogen peroxide solution and mix the solution. We get a pink solution.
- Finally, we arrange tubes A to F according to the decreasing oxidation number of manganese.

The task

- Compare the redox properties of $KMnO_4$ and H_2O_2 in acidic and basic media using standard redox potential values.

G Neutralization

- To 2 cm^3 of HCl solution with a concentration of $c(HCl) = 0.1$ mol dm^{-3}, add one drop of a universal indicator solution or one drop of a methyl red solution and 1.8 cm^3 of a KOH solution with a concentration of $c(KOH) = 0.1$ mol dm^{-3}. Then drop by drop we add KOH solution with a concentration of $c(KOH) = 0.01$ mol dm^{-3} up to the equivalent point (the colour of the indicator corresponds to pH = 7, or pH > 6.3)

$$KOH(aq) + HCl(aq) \longrightarrow KCl(aq) + H_2O(l)$$

$$H_3O^+(aq) + OH^-(aq) \rightleftarrows 2\ H_2O(l)$$

- To 4 cm^3 of NaOH solution with concentration $c(NaOH) = 0.1$ mol dm^{-3} in a large test tube, add one drop of phenolphthalein solution and 1.8 cm^3 of H_2SO_4 solution with concentration $c(H_2SO_4) = 0.1$ mol dm^{-3}. Then drop by drop we add the H_2SO_4 solution with a concentration of $c(H_2SO_4) = 0.02$ mol dm^{-3} up to the equivalent point (the indicator becomes discoloured).

$$NaOH(aq) + 2\ H_2SO_4(aq) \longrightarrow Na_2SO_4\ (aq) + 2\ H_2O(l)$$

$$H_3O^+(aq) + OH^-(aq) \rightleftarrows 2\ H_2O(l)$$

H Hydrolysis

- Fill two small test tubes to about half the volume with distilled water. Add a few crystals of sodium sulfite to one test tube, add a few crystals of sodium carbonate to the other test tube. Add a drop of phenolphthalein solution to both solutions. The colour of the indicator in the sodium carbonate solution will be more intense. Hydrolysis is expressed by chemical equations:

$$SO_3^{2-}(aq) + H_2O(aq) \rightleftarrows HSO_3^-(aq)\ (aq) + OH^-(aq)$$

$$CO_3^{2-}(aq) + H_2O(aq) \rightleftarrows HCO_3^-(aq)\ (aq) + OH^-(aq)$$

- Fill two small test tubes to about half the volume with distilled water. Add a few crystals of sodium bisulfite to one test tube, add a few crystals of sodium bicarbonate to the other test tube. Add a drop of universal indicator solution to both solutions. The anion HSO_3^- behaves as a Brønsted acid in aqueous solution (has an acidic reaction), the anion HCO_3^- behaves as a Brønsted base in aqueous solution (has a basic reaction). Hydrolysis is expressed by chemical equations:

$$HSO_3^-(aq) + H_2O(aq) \rightleftarrows SO_3^{2-}(aq) + H_3O^+(aq)$$

$$HCO_3^-(aq) + H_2O(aq) \rightleftarrows H_2CO_3(aq) + OH^-(aq)$$

I Reactions of magnesium, calcium, strontium and barium salts

- Pour 2 – 3 cm^3 of sodium carbonate solution with $c = 1$ mol dm^{-3} into four test tubes.
- Add 1 – 2 cm^3 of solutions of Mg^{2+}, Ca^{2+}, Sr^{2+} and Ba^{2+} salts (chlorides or nitrates) with $c = 0.1$ mol dm^{-3}.
- Repeat the experiment with ammonium carbonate solution with $c = 1$ mol dm^{-3}.
- Pour 1 – 2 cm^3 of Mg^{2+}, Ca^{2+}, Sr^{2+} a Ba^{2+} salts into four test tubes.
- Add dropwise sulphuric acid diluted in the ratio 1 : 3.
- Note your observations and explain them with the chemical equations.

	$Na_2CO_3(aq)$	**$(NH_4)_2CO_3(aq)$**	**$H_2SO_4(aq)$**
$Mg^{2+}(aq)$			
$Ca^{2+}(aq)$			
$Sr^{2+}(aq)$			
$Ba^{2+}(aq)$			

J Amminkomplexné katióny niektorých prechodných prvkov

Ammonia in water ionizes and behaves as a weak base. Slightly soluble hydroxides are formed according to the equation

$$M^{2+}(aq) \ + \ 2\,NH_3(aq) \ + \ 2\,H_2O(l) \longrightarrow M(OH)_2(s) \ + \ 2\,NH_4^+(aq)$$

Cobalt, copper, zinc, nickel and cadmium hydroxides are poorly soluble in water. However, in an excess of ammonia, they dissolve to form water-soluble complex ammin cations.

$$M(OH)_2(s) \ + \ 6\,NH_3(aq) \longrightarrow [M(NH_3)_6]^{2+}(aq) \ + \ 2\,OH^-(aq)$$

$$Zn(OH)_2(s) \ + \ 4\,NH_3(aq) \longrightarrow [Zn(NH_3)_4]^{2+}(aq) \ + \ 2\,OH^-(aq)$$

Chemicals

- nickel(II) nitrate solution, $Ni(NO_3)_2$, $c(Ni(NO_3)_2) = 0.1$ mol dm^{-3}
- cobalt(II) nitrate solution, $Co(NO_3)_2$, $c(Co(NO_3)_2) = 0.1$ mol dm^{-3}
- copper(II) nitrate solution, $Cu(NO_3)_2$, $c(Cu(NO_3)_2) = 0.1$ mol dm^{-3}
- zinc(II) nitrate solution, $Zn(NO_3)_2$, $c(Zn(NO_3)_2) = 0.1$ mol dm^{-3}
- cadmium(II) nitrate solution, $Cd(NO_3)_2$, $c(Cd(NO_3)_2) = 0.1$ mol dm^{-3}
- concentrated ammonia solution, NH_3, $w(NH_3) = 0.26$
- sodium hydroxide solution, NaOH, $c(NaOH) = 2$ mol dm^{-3}

Procedure

We put about 1 cm^3 of nickel nitrate solution into the test tube and drop by drop we add a solution of ammonia diluted in a ratio of 1:1. A light green precipitate of nickel hydroxide will begin to separate. Next, add a concentrated solution of ammonia until the precipitate dissolves forming a purple-blue solution containing the complex hexaamminnickel cation. We will write the chemical equations of the reactions!

- We repeat the mentioned procedure with a solution of cobalt nitrate, copper nitrate, zinc nitrate and cadmium nitrate. We observe colour changes and record them. We will write the chemical equations of the reactions!
- Add sodium hydroxide solution drop by drop to clear solutions containing complex amino cations. We observe colour changes and record them. We will write the chemical equations of the reactions!

K Precipitation reactions

Chemicals

The following pairs of solutions with $c = 0.20$ mol dm^{-3}.

- barium chloride and potassium carbonate,
- cobalt(II) chloride and potassium hydroxide,
- copper(II) sulphate and potassium iodide,
- iron(III) nitrate and silver nitrate,
- lead(II) nitrate and sodium carbonate,
- nickel(II) sulphate and potassium hydroxide.

Procedure

Mix a few drops of each pair of solutions on a watch glass. We observe changes and record them. We will write the equations of the relevant chemical reactions! If a precipitate has formed, we write the chemical equation also in abbreviated particle form.

The task

Based on the solubility rules, predict what will happen if we mix the following aqueous solutions.

- lead nitrate solution and sodium chloride solution
- lead nitrate solution and sodium sulfate solution
- ferric chloride solution and sodium hydroxide solution
- nickel nitrate solution and sodium hydroxide solution

L Determination of the pH of solutions with indicator paper

The universal indicator paper has the ability to change its colour to red – acidic solutions of pH < 7 and to blue – basic solutions of pH > 7. Each package contains a colour scale that indicates the colour change as a function of pH. To determine the pH value more accurately, we can choose an indicator paper with a more sensitive scale for the range of the pH value for both acids and bases.

Procedure

Put a small amount of the prepared aqueous solutions into the test tubes: CH_3COOH, HCl, Na_2CO_3, NH_4Cl, $CuSO_4$, NaCl a NaOH. From each solution, use a glass rod to drop onto a piece of universal indicator paper placed on a watch glass. We compare the colour change with the scale. We write the results in a table.

	Expected pH (pH < = > 7)	Observed pH
0.5 M CH_3COOH		
0.01 M HCl		
0.1 M HCl		
3% Na_2CO_3		
3% NH_4Cl		
1.2 M $CuSO_4$		
Demineralized water		
1.0 M NaCl		
3% NaOH		

Tasks

- Determine the pH of different solutions, write the values in the table and give reason for their acidic or basic properties.
- Write the chemical equations of the events taking place.
- What will be the pH of the molecular halide SnI_4 solution?