Oxidation and reduction reactions I

Purpose of exercise: basic knowledge of issues relating to the topic of oxidation and reduction reactions

1. Execution of the exercise

1.1. Reduction by metal

1.1.1. Apply a drop of the solution of the following salts to the copper plate: **Hg^{2+}**, **Hg^{2+}_2**, **Ag^{+}**, **Cu^{2+}**, **Bi^{3+}**, **Zn^{2+}**. After a few minutes, wash the plate with distilled water and record the result observation. After complete the exercise, clean the plate with an abrasive paper over the sink.

1.1.2. Apply a drop of the solution of the following salts to the tin plate: **Hg^{2+}**, **Hg^{2+}_2**, **Ag^{+}**, **Cu^{2+}**, **Bi^{3+}**, **Zn^{2+}**. After a few minutes, wash the plate with distilled water and record the result observation. After complete the exercise, clean the plate with an abrasive paper over the sink.

1.1.3. Apply a drop of the solution of the following salts to the aluminum plate: **Hg^{2+}**, **Hg^{2+}_2**, **Ag^{+}**, **Cu^{2+}**, **Bi^{3+}**, **Zn^{2+}**. After a few minutes, wash the plate with distilled water and record the result observation. After complete the exercise, clean the plate with an abrasive paper over the sink.

1.2. Oxidizig properties of hydrogen ions

1.2.1. Up to four test-tubes containing **one!** metal swarf: iron, aluminum, zinc and magnesium add 1 – 2 cm^3 concentrated hydrochloric acid. If necessary heat the test tube [**avoid overheating solution!!! –** test tube should be kept with a wooden paw and evenly heated by a flame – **The outlet of the test tube should always be directed towards the interior of the fume cupboard!!!**]. Observe the emission of hydrogen. After completing the observation of the reaction, pour the contents of the tubes into a specially prepared container in the fume cupboard! **Avoid pouring the contents of the test-tubes into the sink!!!**

1.2.2. Identically attempt to dissolve these metals in **6 M NaOH** – if necessary, heat the test-tube. After completing the observation of the reaction, pour the contents of the tubes into a specially prepared container in the fume cupboard! **Avoid pouring the contents of the test-tubes into the sink!!!**

1.3. Power of oxidants and reducers – prediction of redox reactions

1.3.1. For test-tube containing 1 – 2 cm^3 fresh prepared solution of **Na_2SO_3** add a few drops of **0.01 M I_2** in **KI**, ie. **I_3^-** [bottle marked as: **"I_2"**].

1.3.2. For test-tube containing 1 – 2 cm^3 fresh prepared solution of **$NaNO_2$** add a few drops of **2 M HCl** and a few drops of **KI**. Check the presence of iodine by adding a drop of starch solution.

1.4. Influence temperature on redox reaction direction

1.4.1. To a 1 – 2 cm^3 solution of **0.1 M** ammonium oxalate **[$(NH_4)_2C_2O_4$]** add a few drops of **2 M H_2SO_4**. Then add a few drops of **0.01 M $KMnO_4$** - if you do not see change the color after 1-2 minutes, the solution can be gently heated.

1.4.3. To a 0.5 - 1 cm^3 of **6% H_2O_2** solution, add a few drops of **2 M NaOH** and a few drops of **Cr^{3+}** salt. Shake the solution briefly, then pour half the solution into the second test-tube and add a few drops of **Pb^{2+}** salt

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solution to determine the presence of chromate ions in the sample. Heat the rest of the solution gently for one minute, then cool the solution and react again to the presence of chromate ions with **Pb^{2+}** ions.

1.4.4. Pour some solid **PbO_2** into the test tube, add 1 - 2 cm^3 of **2 M HNO_3** solution and a few drops of the solution containing **Mn^{2+}** ions. Then heat up the solution slightly. Observe the colour of the solution after the sediment has settled.

2. Development of results

- Based on the observed changes on the surface of the metal plate, justify the changes by writing out the normal potentials and comparing them.
- Write reactions that occur when dissolving metals in acids and bases. Justify the evolution of hydrogen during the reaction of metals in an acidic and alkaline environment.
- Write an electron balance for the reactions performed and justify the direction of the reaction based on the normal redox potentials of the products and substrates. Calculate the equilibrium constants for the redox reactions performed.
- Record the observed differences in the speed of reactions at room temperature and the temperature several times higher. Write the equation of reaction, electron balance and mark any colour changes during the reaction.
- Write the reaction, electron balance and normal potentials for the reactants.

3. Conclusion

For each of the above mentioned points, give a concise conclusion resulting from the experiment.

4. The scope of material

- Oxidizing agent, oxidation.
- Reducing agent, reduction.
- Oxidation state.
- Normal potential.
- Voltage metal series.
- Power of oxidizer and reducer.
- Chemical and electrochemical reactions.
- Nernst equation.
- Ability to write redox reactions and prediction of direction based on normal redox potentials.

5. Literature

G. Charlot *Qualitative Inorganic Analysis,* Wiley 2007
(https://archive.org/details/in.ernet.dli.2015.151602)
Ulrich Müller *Inorganic Structural Chemistry, 2nd Edition, Wiley 2006*

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