

Identification of selected cations and anions



ACT WITH GREAT CAUTION!

**DO NOT COVER A TEST
TUBE WITH YOUR FINGER**



ACT WITH GREAT CAUTION!

**HEAT ONLY ONE
TEST TUBE OVER
A BURNER AT A
TIME**

Task 1

The aim of the task is to detect Ca^{2+} (calcium) ions

Procedure

a. Test with $\text{C}_2\text{O}_4^{2-}$ (oxalate) ions

Add about 0.5 cm^3 of 0.2 mol/dm^3 ammonium oxalate ($\text{NH}_4\text{C}_2\text{O}_4$) to 0.5 cm^3 of Ca^{2+} solution.

Reaction:



The resulting CaC_2O_4 precipitate is white, crystalline. If you add several drops of ammonia to a test tube, in which the reaction has occurred, the amount of precipitate is greater. Calcium oxalate is soluble in mineral (inorganic) acids, and insoluble in acetic acid.

b. Test with SO_4^{2-} (sulphate) ions

Add several drops of concentrated H_2SO_4 (sulphuric acid) to 0.5 cm^3 of Ca^{2+} solution.

Reaction:



Reaction with sulphuric acid results in the precipitation of white CaSO_4 (copper sulphate).



Task 2

The aim of the task is to detect NH_4^+ (ammonium) ions

Procedure

Add about 0.5 cm^3 of 2 mol/dm^3 NaOH to 0.5 cm^3 of NH_4^+ solution, and heat the contents of the test tube over a burner.

Reaction:



Observe the change of litmus paper colour and the characteristic odour of escaping ammonia at the mouth of the test tube.

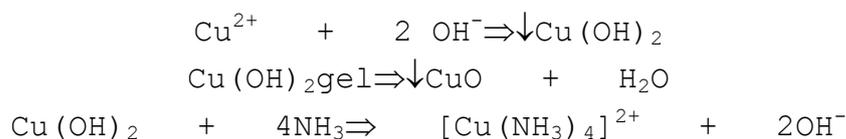
Task 3

The aim of the task is to detect Cu^{2+} (copper) ions

Procedure

Take two test tubes, pour into each 0.5 cm^3 of Cu^{2+} solution, and then add 0.5 cm^3 of 2 mol/dm^3 NaOH. After the precipitation of $\text{Cu}(\text{OH})_2$, heat one test tube over a burner, and add 0.5 cm^3 of concentrated $\text{NH}_3 \cdot \text{H}_2\text{O}$ to the other test tube.

Reactions:



Task 4

The aim of the task is to detect Fe^{3+} (iron) ions

Procedure

a. Test with potassium thiocyanate

Add 0.5 cm^3 of 1 mol/dm^3 KSCN (potassium thiocyanate) to 0.5 cm^3 of Fe^{3+} solution.

Reaction:



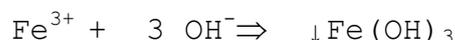
Observe the change of solution colour. Fe^{2+} ions do not give this reaction.



b. Test with sodium hydroxide

Add 0.5 cm³ of 2 mol/dm³ NaOH to 0.5 cm³ of Fe³⁺ solution.

Reaction:



Observe the formation of red-brown Fe(OH)₃ precipitate, which is insoluble in an excess of the reagent.

Task 5

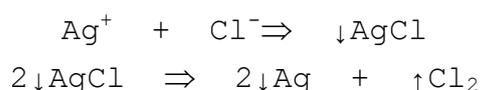
The aim of the task is to detect Ag⁺ (silver) ions

Procedure

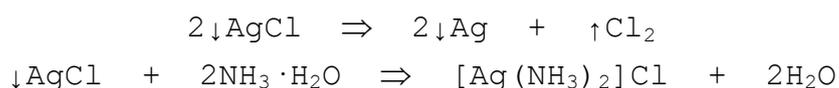
a. Test with Cl⁻ (chlorine) ions

Take two test tubes, pour into each 0.5 cm³ of Ag⁺ solution, and then several drops of concentrated HCl (hydrochloric acid). One test tube expose to sunlight and after some time observe photochemical reaction occurring in the test tube. Carefully heat the other test tube and observe the precipitate. Cool the test tube, then add drop by drop 2 mol/dm³ NH₃·H₂O until the formation of soluble silver diamine chloride ([Ag(NH₃)₂]Cl), and next add drop by drop concentrated HNO₃ until the reappearance of AgCl precipitate.

Ag⁺ ions, occurring in neutral or acid solutions, react with Cl⁻ ions forming white, cheese-like precipitate of silver chloride (AgCl), which decomposes when exposed to light and darkens due to the precipitation of colloidal silver.



AgCl precipitate is insoluble in both cold and hot pure water but in the presence of ammonium ions it forms soluble, colourless, complex ion [Ag(NH₃)₂]⁺.



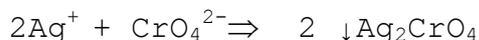
The addition of nitric acid causes the reprecipitation of AgCl.

b. Test with CrO₄²⁻ (chromate) ions

Add 0.5 cm³ of 0.1 mol/dm³ K₂CrO₄ to 0.5 cm³ of Ag⁺ solution.



After the precipitation of Ag_2CrO_4 , add several drops of concentrated nitric acid to the test tube. Observe the course of reaction.



Potassium chromate (K_2CrO_4) causes the precipitation of red-brown silver chromate (Ag_2CrO_4) from the solutions containing Ag^+ ions. This reaction has found practical application in the quantitative determination of silver in jewellery because the intensity of colour of formed Ag_2CrO_4 depends on the amount of silver in the alloy, from which jewellery has been made.

Task 6

The aim of the task is to detect Pb^{2+} (lead) ions

Procedure

a. Test with Cl^- (chlorine) ions

Add several drops of concentrated HCl to 0.5 cm^3 of Pb^{2+} solution.

Reaction:



The precipitate of lead chloride (II) is formed. Add 2 cm^3 of distilled water to the test tube and heat until the precipitate is dissolved. After cooling, observe the formed crystals.

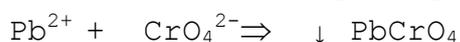
Cl^- ions, added to the solutions containing Pb^{2+} ions, cause the precipitation of white, crystalline lead chloride (II), which quickly settle on the test tube bottom.

This precipitate dissolves after heating in the test tube, and after cooling it reprecipitates in the form of needle-like crystals.

Test with heating silver and lead chlorides is important because it is used to easily distinguish AgCl from PbCl_2 (AgCl is insoluble in hot water).

a. Test with chromate

Add 0.5 cm^3 of $0.1 \text{ mol/dm}^3 \text{ K}_2\text{CrO}_4$ to 0.5 cm^3 of Pb^{2+} solution. After a few minutes, examine the formed precipitate.



Potassium chromates (K_2CrO_4 and $K_2Cr_2O_7$), added to the solutions containing Pb^{2+} ions, causes the precipitation of yellow lead chromates (II).

Task 7

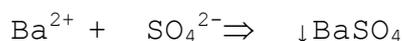
The aim of the task is to detect Ba^{2+} (barium) ions

Procedure

a. Test with SO_4^{2-} (sulphate) ions

Add 0.5 cm^3 of 0.1 mol/dm^3 H_2SO_4 to 0.5 cm^3 of Ba^{2+} solution.

Reaction:

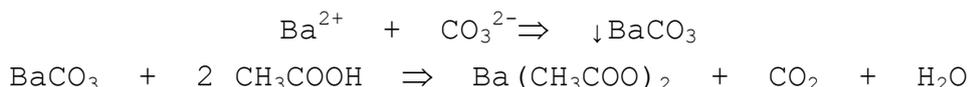


Sulphuric acid (VI) causes the precipitation of white $BaSO_4$, which is insoluble in water.

b. Test with CO_3^{2-} (carbonate) ions

Add 0.5 cm^3 of 0.2 mol/dm^3 Na_2CO_3 to 0.5 cm^3 of Ba^{2+} solution. After the precipitation of $BaCO_3$, add 1 cm^3 of concentrated CH_3COOH .

Reactions:



Carbonate ions, added to the solutions containing Ba^{2+} ions, cause the precipitation of white barium carbonate (II), which is easily soluble in acetic acid. If the precipitate is not dissolved, you can add 1 cm^3 of CH_3COOH more.

Task 8

The aim of the task is to detect Cl^- (chloride) ions

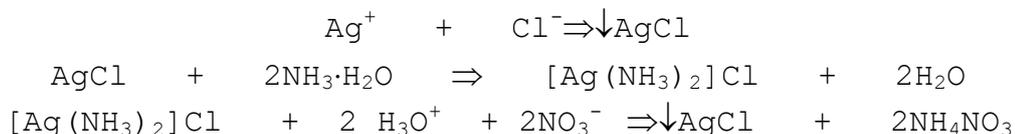
Procedure

a. Test with Ag^+ (silver) ions

Add drop by drop about 0.5 cm^3 of 0.1 mol/dm^3 $AgNO_3$ to 0.5 cm^3 of Cl^- solution. Dissolve the resulting precipitate adding 2 mol/dm^3 $NH_3 \cdot H_2O$ drop by drop. Then add several drops of

concentrated HNO_3 in order to cause the reprecipitation of AgCl .

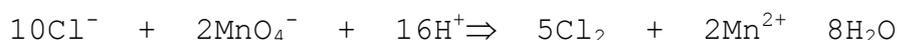
Reactions:



b. Test with potassium permanganate

Add 0.5 cm^3 of 0.1 mol/dm^3 KMnO_4 and several drops of concentrated H_2SO_4 to 0.5 cm^3 of Cl^- solution.

Reaction:



Potassium permanganate, as strong oxidant, is reduced in acid environment (the solution becomes discoloured), while Cl^- , as weak reducer, escapes in the form of gas with a characteristic odour.

Task 9

The aim of the task is to detect CO_3^{2-} ions

Procedure

a. Test with strong acid

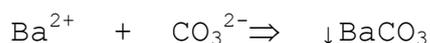
Add drop by drop 2 mol/dm^3 H_2SO_4 to 0.5 cm^3 of CO_3^{2-} solution. Observe the course of reaction.



b. Test with Ba^{2+} ions

Add 0.5 cm^3 of 0.1 mol/dm^3 BaCl_2 to 0.5 cm^3 of CO_3^{2-} solution.

Reaction:



White precipitate of barium carbonate is soluble in acetic, nitric and hydrochloric acids, and insoluble in sulphuric acid.

Task 10

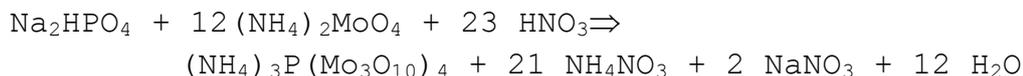
The aim of the task is to detect PO_4^{3-} ions



Procedure

Add 5 drops of concentrated HNO_3 and 0.5 cm^3 of $(\text{NH}_4)_2\text{MoO}_4$ to 0.5 cm^3 of PO_4^{3-} solution. Heat the test tube over a burner.

Reaction:



Task 11

The aim of the task is to detect SO_4^{2-} ions

Procedure

a. Test with Pb^{2+} (lead) ions

Add 0.5 cm^3 of 2 mol/dm^3 $\text{Pb}(\text{CH}_3\text{COO})_2$ to 0.5 cm^3 of SO_4^{2-} solution.

Reaction:



The resulting white precipitate of PbSO_4 is insoluble in inorganic acids, except concentrated sulphuric acid (VI), and it is also insoluble in concentrated NaOH and KOH .

b. Test with Ba^{2+} (barium) ions

Add 0.5 cm^3 of 1 mol/dm^3 barium chloride (BaCl_2) to 0.5 cm^3 of SO_4^{2-} solution.

Reaction:



The resulting white precipitate of BaSO_4 is insoluble in HCl and HNO_3 even after heating, while it is soluble in concentrated H_2SO_4 .

Task 12

The aim of the task is to detect $\text{C}_2\text{O}_4^{2-}$ ions

Procedure

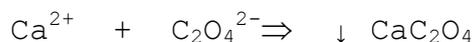
a. Test with CaCl_2

Add drop by drop 0.5 cm^3 of 1 mol/dm^3 CaCl_2 to 0.5 cm^3 of $\text{C}_2\text{O}_4^{2-}$



solution.

Reaction:

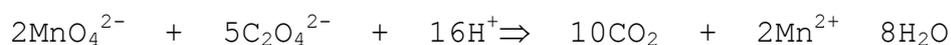


Calcium chloride causes the precipitation of white crystalline precipitate, which is soluble in mineral acids, and insoluble in acetic acid.

b. Test with potassium permanganate

Add 0.5 cm³ of 0.1 mol/dm³ KMnO₄ and 0.5 cm³ of concentrated H₂SO₄ to 0.5 cm³ of C₂O₄²⁻ solution.

Reaction:



Potassium permanganate becomes discoloured in acid solution containing oxalate ions (C₂O₄²⁻). Characteristic bubbles of CO₂ are formed during this reaction.

Lublin, 20 november 2016.

