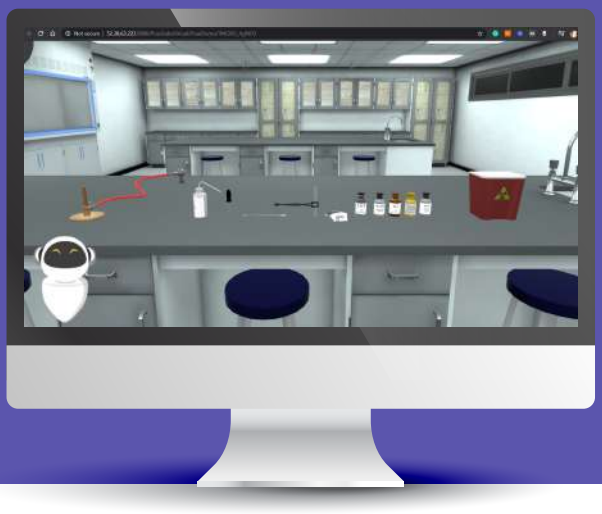
Chemistry | Inorganic Chemistry

Test for Silver radical



General Aim

Detection of the presence of silver ions as a base radicals in inorganic salts such as silver nitrate.

Method

Detection of the presence of silver as a base radical using specific chemical reagents.

Learning Objectives (ILOs)

- Define and differentiate between members of the first group cations and those of other cation groups.
- Classify inorganic salts according to their base radicals.
- Compare between silver containing salts and other members of the same group in terms of chemical structures, properties and reactions.
- Identify silver radicals containing salts experimentally.
- Select the appropriate reagents to detect the presence of silver radical.
- Balance the chemical equations of chemical reactions.

Theoretical Background/Context

- Silver is a noble metal since it is a rare and precious metal. In addition, it does not react or get oxidized easily. It can be found in very minute amounts that does not exceed 0.05 parts per million in the earth. For example, 20 million shovels of dirt should be collected to obtain only one shovel full of silver. Long ago, silver was more valuable than gold owing to the facile location and refining of gold at that time. However, nowadays, silver is ten times more abundant and consequently cheaper than gold.

Abundance of Silver in Nature

Silver occurs naturally in a pure as well as combined forms in ores. Some of the important silver ores include Argentite (Ag2S), Copper silver glance, Horn silver, and Ruby silver. Silver ores can be found accompanied with gold ores. Argentite ores are considered as the most abundant ones.

Extraction of Silver from Argentite Ores

Silver is extracted from Argentite (Ag2S) via cyanide extraction process using sodium cyanide solution. The ore is obtained and crushed then treated with sodium cyanide solution. Reaction of the ore and cyanide solution results in formation of sodium argento cyanide as shown in the following equation:

$$Ag2S + 4NaCN \quad 2\,Na\,[Ag\,(CN)2] + Na2S$$

Afterwards, sodium argento cyanide solution reacts with zinc forming sodium tetra cyanozicate and precipitated silver.

$$Zn + 2Na[Ag(CN)2] \rightarrow Na2[Zn(CN)4] + 2Ag\downarrow$$

The obtained silver is purified by its fusion with potassium nitrate, then the silver is extra purified again through some electrolytic processes.

Theoretical Background/Context (Cont')

Properties and Uses of Silver

Mixed silver and mercury are used in some preparations in dental applications owing to antibacterial activity. Since, silver is a good conductor, it can be used in electroplating as well as manufacturing of batteries and catalysts.

Pure silver is too soft to manufacture jewelry and utensils. Therefore, it is usually alloyed with at least one more metal. For instance, sterling silver consists of about 93% silver and 7% other metals.

Silver Salts

Silver nitrate is one of the most commonly available and used silver salts. Silver nitrate is an inorganic compound with a chemical formula of $AgNO_3$. Silver nitrate was once called lunar caustic since silver was called luna by the ancient alchemists who believed that silver was associated with the moon. Silver nitrate was first discovered and prepared by Albertus Magnus.

Preparation of Silver Salts

Silver nitrate is prepared by adding dilute or concentrated nitric acid to silver as they react together resulting in formation of silver nitrate, water and nitrogen oxides as shown in the following reaction. The reaction should be carried out in a fume hood to keep away the toxic nitrogen oxides gases.

$$3\ Ag + 4\ HNO_3(dil) \rightarrow 3\ AgNO_3 + 2\ H_2O + NO$$
$$Ag + 2\ HNO_3(conc) \rightarrow\ AgNO_3 + 2\ H_2O + NO$$

Properties and Uses of Silver Nitrate

- Silver nitrate is a white crystalline salt that is freely soluble in hot water forming colorless aqueous solutions.
- Silver nitrate has antiseptic and antimicrobial activities therefore it is used in some medical applications such as dental
- preparations, healing ulcers and microbial disinfectants.
- Silver nitrate solutions can stain some biological specimens, so it is used to investigate reticular fibers, proteins and nucleic acids.
- Silver nitrate has been used long ago in photography, then recently has been used in radiography.

Principle of Work

- In this experiment, silver ion in silver nitrate is detected through some identification and confirmatory tests. The silver radical is among the first group of basic radicals in which hydrochloric acid is used as a group reagent.
- During the experiment, salt solubility in water will be tested. Then the behavior of the salt will be tested with hydrochloric acid followed by confirmatory tests which will be performed using sodium hydroxide, potassium iodide and potassium chromate reagents to confirm the presence of silver radical in the salt.

First: Solubility Test

In this test, a sample of the silver salt is tested for its solubility in hot water.

Second: Dilute Hydrochloric Acid Test

It depends on the fact that dil. HCl can displace nitrate ions in silver nitrate salt forming silver chloride salt which is a white precipitate. The precipitated salt can dissolve in ammonium hydroxide solution. The reaction between silver nitrate and HCl is shown below.

$$AgNO_3 + HCl \rightarrow HNO_3 + AgCl \downarrow \text{(White ppt.)}$$

Third: Sodium Hydroxide Test

Sodium Hydroxide solution is added to aqueous silver nitrate leading to the precipitation of silver oxide as a dark brown precipitate due to its low solubility product. The reaction of the test is:

$$2\ AgNO3 + 2\ NaOH \rightarrow 2\ NaNO3 + H2O + Ag2O \downarrow \text{(Brown ppt.)}$$

Forth: Potassium Iodide Test

Potassium iodide solution is added to silver nitrate aqueous solution resulting in precipitation of silver iodide as a yellow precipitate due to low solubility product as shown in the following chemical reaction:

$$AgNO3 + KI \rightarrow KNO3 + AgI \downarrow \text{(Yellow ppt.)}$$

Fifth: Potassium Chromate Test

Potassium chromate test is considered as a specific test for detection of the presence of silver ions as the basic radicals of a salt. The test depends on adding potassium chromate solution to aqueous silver nitrate solution leads to the formation of red brick colored precipitate of silver chromate according to the following reaction:

$$K2CrO4 + 2\ AgNO3 \rightarrow 2\ KNO3 + Ag2CrO4 \downarrow$$