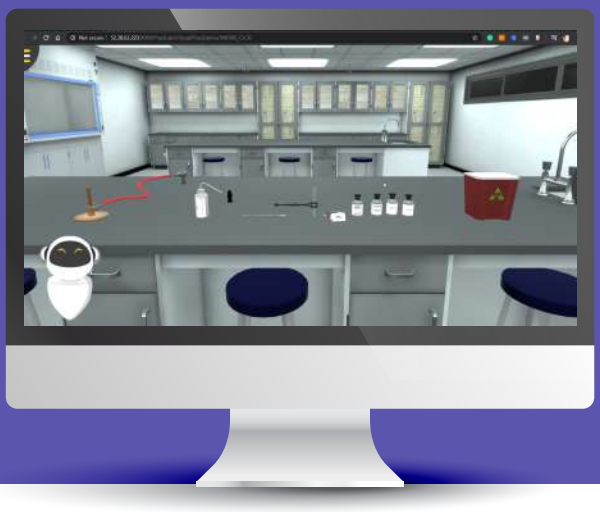
Chemistry | Inorganic Chemistry

Test for Chromic Radical



General Aim

Detection of the presence of chromic ion as a base radical in inorganic salts such as chromic chloride.

Method

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

Learning Objectives (ILOs)

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

Theoretical Background/Context

Chromium (Cr) is a metal whose atomic number is 24 and located in group 6 in the periodic table. Its name is derived from the Greek word chroma which means color in English owing to the colored chromium containing compounds.

Abundance of Chromium in Nature: In the Earth's crust, chromium is the 21st most abundant element. Its recorded average concentration is 100 ppm in the Earth's crust. Chromium compounds are abundant in the surrounding environment due to the erosion of chromium-containing rocks during volcanic eruptions. Chromium is also fined in ($FeCr_2O_4$) ore as chromite.

Properties and Uses of Chrome: Chrome is a brittle and hard metal possessing a lustrous appearance, a steely-grey color and a high melting point. Therefore, chrome is used in electroplating and polishing to increase resistance to tarnishing. Similar to aluminum, chrome has been also used in stainless steel industries due to its robustness. However, chromium possesses more and different oxidation states than aluminum. Chromium most abundant oxidation states are 2+, 3+ and 6+.

Chromium Salts: Although chromium III compounds are not toxic, chromium VI compounds reported high toxicity. In addition, chromium III is the most stable oxidation state. They are also characterized by possessing specific colors upon reacting with some chemicals.

Preparation of Chromium Salts: Chromium (III) salts can be obtained directly through reacting the elemental chromium with concentrated acids such as hydrochloric acid or sulfuric acid to produce chromium chloride or chromium sulfate, respectively. It can be also prepared through carbothermic chlorination of chromium oxide as shown below.

$$2\,Cr + 6\,HCl \rightarrow 2\,CrCl_3 + 3H_2$$

$$2\,Cr + 3\,H_2SO_4 \rightarrow Cr_2(SO_4)_3 + 3\,H_2$$

$$Cr_2O_3 + 3\,C + 3Cl_2 \rightarrow 2\,CrCl_3 + 3\,CO$$

In addition, it can be also produced by reducing chromium VI using cytochrome c7.

Theoretical Background/Context

Properties and Uses of Chromium Chloride

- Chromium chloride is a violet crystalline salt in its anhydrous form, while its color changes into dark green when it is hydrated.
- Chromium chloride is a reducing agent so it is used in organic synthesis procedures involving reduction of alkyl halides.
- Chromium chloride containing dyes have been widely used in wool staining.
- Chromium chloride has been used as a Lewis acid and catalyst in many organic reactions such as Diels Alder.
- Some studies claim that chromium (III) salts are essential in humans for insulin, sugar and lipid metabolism when used in trace amounts.

- Chromium containing compounds are used in various medications such as medications for treatment of prediabetes, diabetes, as well as medications for improving athletic performance, and preventing age-related mental decline.

Principle of Work

- In this experiment, chromium ion in chromium chloride is detected through some identification and confirmatory tests. The chromium radical is among the third group of basic radicals in which ammonia is used as group reagents.
- During the experiment, salt solubility in water will be tested on cold and hot. Then the behavior of the salt will be tested with ammonia followed by confirmatory tests which will be performed using sodium hydroxide, sodium phosphate, and sodium carbonate reagents to confirm the presence of chromium radical in the salt.

First: Solubility Test

In this test, a sample of the chromium salt is tested for its solubility in water on cold and hot.

Second: Ammonia Test

It depends on the fact that ammonia can displace chloride ions in chromium chloride salt forming insoluble gelatinous green precipitate of chromium hydroxide which is soluble in excess ammonia.

$$CrCl3 + 3\ NH4OH \rightarrow 3\ NH4Cl + Cr(OH)3 \downarrow \text{(Gel green ppt.)}$$

$$Cr(OH)3 + 6\ NH3 \rightarrow [Cr(NH3)6](OH)3$$

Third: Sodium Hydroxide Test

Sodium Hydroxide solution is added to aqueous chromium chloride leading to the precipitation of chromium hydroxide as a gelatinous grey green precipitate which is soluble in excess sodium hydroxide due to formation of sodium chromite Na[CrO2]. The reaction of the test is:

$$CrCl3 + 3\ NaOH \rightarrow 3\ NaCl + Cr(OH)3 \downarrow \text{(Greyish green ppt.)}$$

$$Cr(OH)3 + NaOH \rightarrow Na[CrO2] + H2O$$

Fourth: Sodium Phosphate Test

Sodium phosphate solution is added to chromium chloride aqueous solution resulting in precipitation of chromium phosphate as a green precipitate due to low solubility product of chromium phosphate as shown in the following chemical reaction:

$$CrCl3 + Na3PO4 \rightarrow 3\ NaCl + CrPO4 \downarrow \text{(Green ppt.)}$$

Fifth: Sodium Carbonate Test

Sodium carbonate test is considered as a confirmatory test for the detection of the presence of chromium ions as the basic radical of a salt. The test depends on adding sodium carbonate solution to aqueous chromium chloride solution leading to the formation of green colored precipitate of chromium hydroxide due to hydrolysis of chromium carbonate according to the following reaction:

$$CrCl3 + Na2CO3 + H2O \rightarrow CO2 + NaCl + Cr(OH)3 \downarrow \text{(Green)}$$