

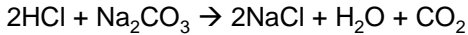
# Qualitative Analysis: Anions & Cations

## Testing for Negative ions (anions)

### Testing for presence of a carbonate

Add any dilute acid and observe effervescence.

Bubble gas through limewater to test for CO<sub>2</sub> – will turn limewater cloudy

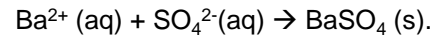


Fizzing due to CO<sub>2</sub> would be observed if a carbonate was present

### Testing for presence of a sulfate

**Acidified** BaCl<sub>2</sub> solution is used as a reagent to test for sulfate ions

If **barium chloride** is added to a solution that contains sulphate ions a **white precipitate** forms



Other anions should give a negative result which is no precipitate forming

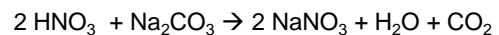
The acid is needed to react with carbonate impurities that are often found in salts which would form a white barium carbonate precipitate and so give a false result

Sulfuric acid cannot be used to acidify the mixture because it contains sulphate ions which would form a precipitate

### Testing for halide ions with silver nitrate.

This reaction is used as a test to identify which halide ion is present. The test solution is made acidic with **nitric acid**, and then **silver nitrate solution** is added dropwise.

The role of nitric acid is to react with any carbonates present to prevent formation of the precipitate Ag<sub>2</sub>CO<sub>3</sub>. This would mask the desired observations

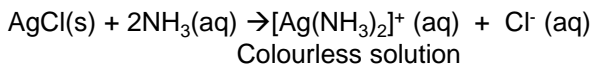


Fluorides produce no precipitate  
Chlorides produce a **white** precipitate  
 $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$   
Bromides produce a **cream** precipitate  
 $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$   
Iodides produce a **pale yellow** precipitate  
 $\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$

Hydrochloric acid cannot be used to acidify the mixture because it contains chloride ions which would form a precipitate

The silver halide precipitates can be treated with ammonia solution to help differentiate between them if the colours look similar:

**Silver chloride** dissolves in **dilute ammonia** to form a complex ion



**Silver bromide** dissolves in **concentrated ammonia** to form a complex ion



**Silver iodide** does not react with ammonia – it is too insoluble.

The sequence of tests required is carbonate, sulfate then halide. (This will prevent false results of as both BaCO<sub>3</sub> and Ag<sub>2</sub>SO<sub>4</sub> are insoluble.)

## Testing for positive ions (cations)

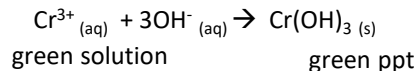
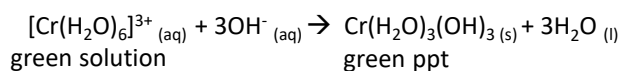
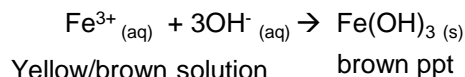
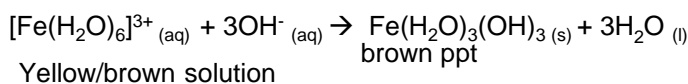
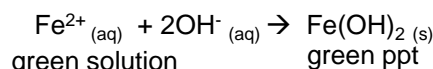
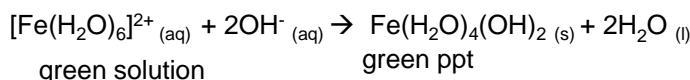
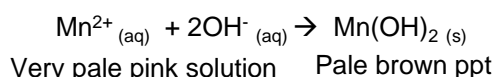
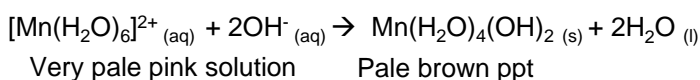
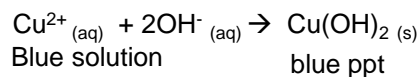
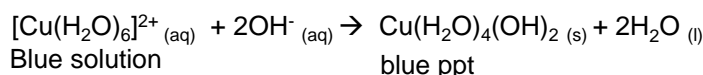
Test for ammonium ion  $\text{NH}_4^+$ , by reacting with warm  $\text{NaOH(aq)}$  forming  $\text{NH}_3$  gas

Ammonia gas can be identified by its pungent smell or by turning red litmus paper blue

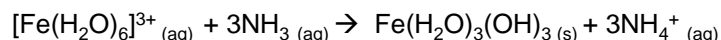
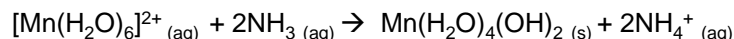
### Precipitation Reactions with sodium hydroxide and ammonia

The bases  $\text{OH}^-$  and ammonia when in limited amounts form the same hydroxide precipitates.

These reactions are classed as precipitation reactions



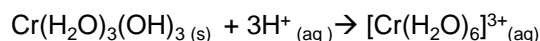
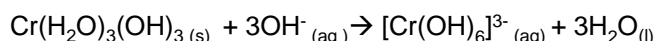
With ammonia when added in limited amounts the same hydroxide precipitates form. The ammonia acts as a base, removes a proton from the aqueous complex and becomes the ammonium ion



### Reaction with excess $\text{OH}^-$

With excess  $\text{NaOH}$ , the Cr hydroxide dissolves. Cr becomes  $[\text{Cr}(\text{OH})_6]^{3-}(\text{aq})$  green solution

• This hydroxide is classed as **amphoteric** because it can react with alkali to give a solution and react with acid to form the aqueous salt



### Reaction with excess $\text{NH}_3$

With **excess  $\text{NH}_3$  ligand exchange** reactions occur with Cu and Cr, and their hydroxide precipitates dissolve in excess ammonia

The ligands  $\text{NH}_3$  and  $\text{H}_2\text{O}$  are similar in size and are uncharged. Ligand exchange occurs without change of co-ordination number for Cr

Cr becomes  $[\text{Cr}(\text{NH}_3)_6]^{3+}$  purple solution

This substitution may, however, be incomplete as in the case with Cu

Cu becomes  $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$  deep blue solution

