3.1.4 Qualitative analysis

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_2 – will turn limewater cloudy

$2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2$

Fizzing due to CO_2 would be observed if a carbonate was present

Testing for presence of a sulfate

$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$.

Acidified $BaCl_2$ solution is used as a reagent to test for sulfate ions.

If **barium chloride** is added to a solution that contains sulfate 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 sulfate 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_2CO_3. This would mask the desired observations.

$2 HNO_3 + Na_2CO_3 \rightarrow 2 NaNO_3 + H_2O + CO_2$

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

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
$AgCl(s) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2]^+(aq) + Cl^-(aq)$
Colourless solution
Silver bromide dissolves in **concentrated ammonia** to form a complex ion
$AgBr(s) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2]^+(aq) + Br^-(aq)$
Colourless solution
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 $BaCO_3$ and Ag_2SO_4 are insoluble.)

Testing for positive ions (cations)

Test for ammonium ion NH_4^+, by the reaction with warm NaOH(aq), forming NH_3 gas

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