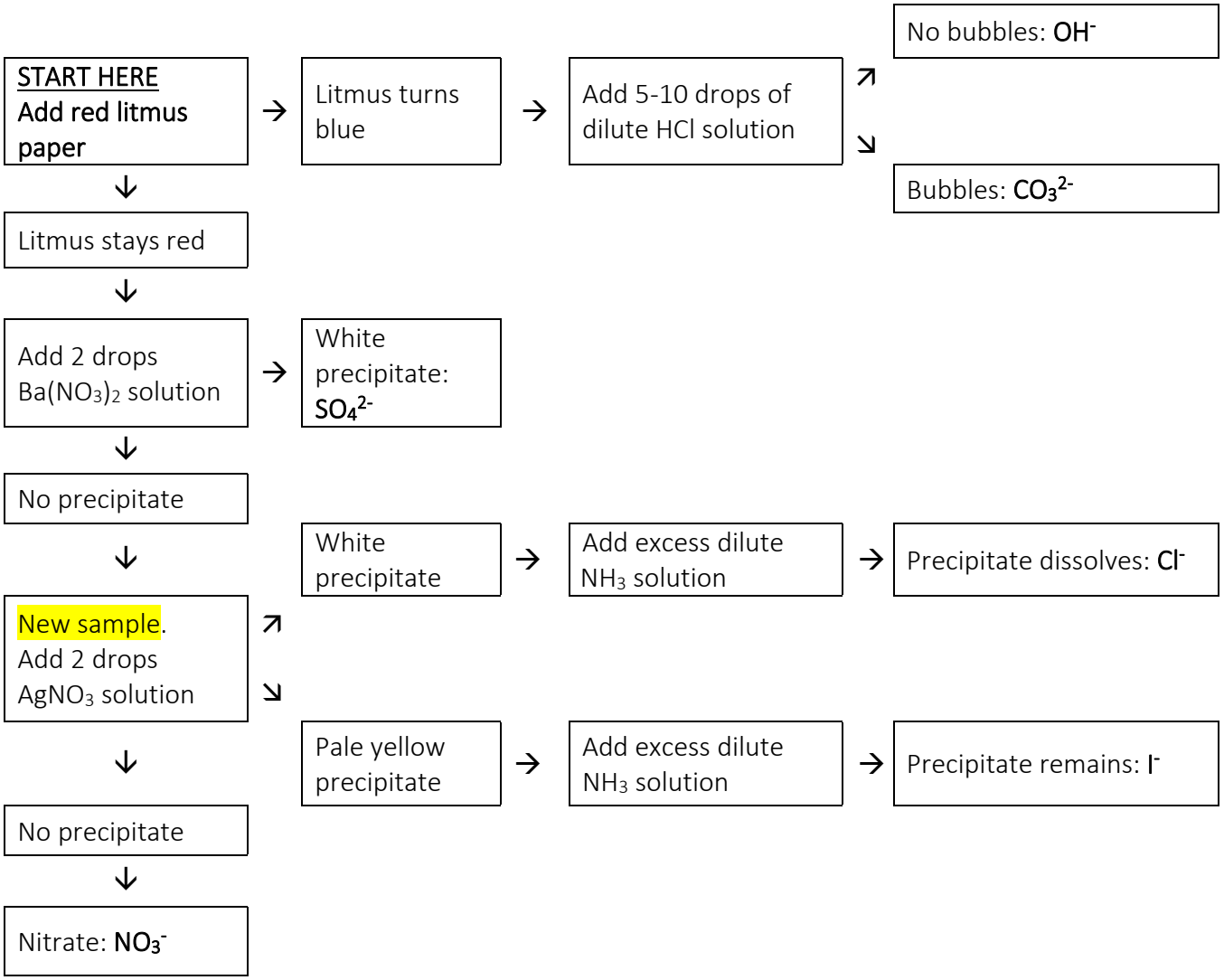
To identify Anions
Cl^-, CO_3^{2-}, I^-, NO_3^-, OH^-, SO_4^{2-}



The Solubility Rules

1. All Group 1 compounds (sodium) are soluble
2. All **nitrate** compounds are soluble
3. Most **sulfates** are soluble **except** for calcium sulfate, barium sulfate and lead sulfate
4. Most **halides** (chlorides and iodides) are soluble **except** for those with silver and lead
5. All **carbonates** are insoluble **except** those of sodium
6. All **oxides** and **hydroxides** are insoluble **except** those of Group 1 (sodium)

Identification of chloride, Cl^-

Chloride ions (Cl^-) can be identified in solution through the use of solubility rules and the ability of the chloride anion to form a complex ion with ammonia.

When a sample is tested with red litmus paper, the paper remains red. This allows for the elimination of the both the basic hydroxide and carbonate anions.

When 2 drops of barium nitrate is added there is no precipitate, excluding the sulfate anion. This is because most sulfates are soluble except for calcium, lead and barium sulfate. If the anion *had* been a sulfate a precipitate of insoluble barium sulfate would form (solubility rule #3).

One way to identify chloride ions in solution is to add a solution of silver nitrate ($AgNO_3$) to a new sample of the unknown solution. This will cause a white precipitate of silver chloride (AgCl) to form according to the following equation:

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

Most halides (chlorides and iodides) are soluble except for those with silver and lead (solubility rule #3) so a precipitate with silver nitrate solution here identifies either silver chloride or silver iodide.

The nitrate anion (NO_3^-) does not form a precipitate with silver nitrate as all nitrates are soluble (solubility rule #3), which is why nitrate ions can be eliminated.

The formation of a white precipitate of AgCl confirms the presence of chloride ions in solution. However, this test alone is not specific enough to conclusively identify chloride ions, as other halide ions such iodide (I^-) can also form a pale yellow precipitate with silver nitrate.

To confirm the presence of chloride ions and exclude iodide ions, an additional test can be performed using ammonia as a complexing agent. Silver ions from AgCl can form a complex ion with ammonia, $[Ag(NH_3)_2]^+$, which is soluble in water.

The overall reaction is: $Ag^+(aq) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2]^+(aq)$

Or

$$AgCl(s) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2]^+(aq) + Cl^-(aq)$$

This complex ion is stable and soluble in water, and the formation of a colourless solution confirms the presence of chloride ions in the solution. A similar stable complex ion does not form if the precipitate had been that of silver iodide.