

Qualitative Analysis

Chemistry 12 AP

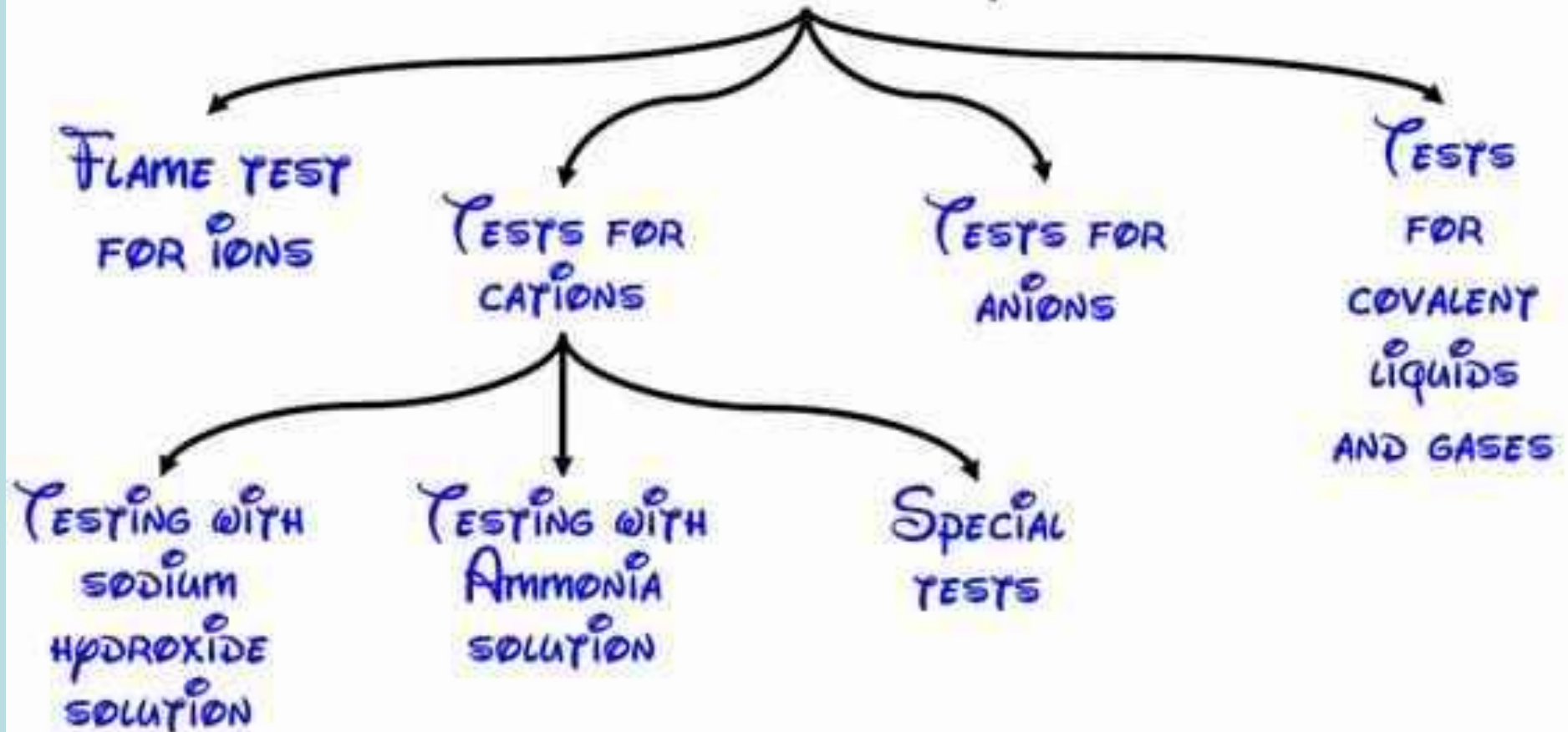
What is Qualitative Chemical Analysis?

- It is a branch of chemistry that deals with the identification of elements or grouping of elements present in a sample.
- There are usually two types: qualitative inorganic analysis and qualitative organic analysis.

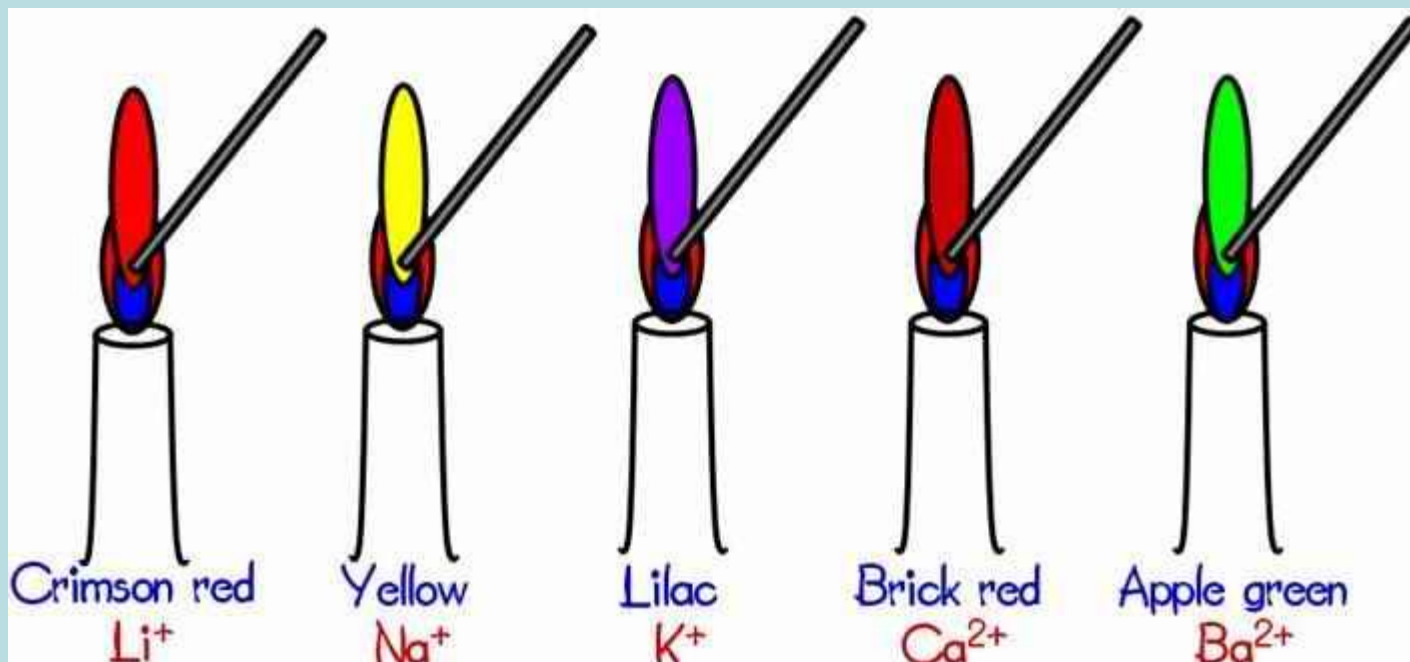
Identifying Ions

- We could use these rules to work out if hydroxides or chlorides are present in a solution. (What is one difference between the two ions?)
- To make life easier we could use a flow chart that shows the order that we need to do tests in order to eliminate possible ions
- These two flow charts divide all ions into two groups – anions and cations. Once we have identified one of the ions in a solution we need to identify the other. Can also use flame tests (for soluble metals), or other tests (see next page).

TESTS AND ANALYSIS



Flame Colours of Solutions



If a flame test produces one of the these colours, that ion is in the solution.
Other colors are possible, but these are the most common.

TESTS FOR CATIONS

Using drops then excess aqueous NaOH or ammonia

- Calcium ions (Ca^{2+})
- Aluminium ions (Al^{3+})
- Copper ions (Cu^{2+})
- Iron (II) ions (Fe^{2+})
- Iron (III) ions (Fe^{3+})
- Zinc ions (Zn^{2+})

Special tests

- Ammonium ions (NH_4^+)
- Hydrogen ions (H^+) for acids
- Silver ions (Ag^+)

Using aqueous sodium hydroxide

TESTS FOR CATIONS

UNKNOWN

Add drops of sodium hydroxide solution

Step	Observation	Excess NaOH	Observation	Cation
1	White precipitate	→	Insoluble in excess	Ca^{2+}
2	White precipitate	→	Soluble in excess	Al^{3+}
3	Blue precipitate	→	Insoluble in excess	Cu^{2+}
4	Dark green precipitate	→	Insoluble in excess	Fe^{2+}
5	Red brown precipitate	→	Insoluble in excess	Fe^{3+}
6	White precipitate	→	Soluble in excess	Zn^{2+}

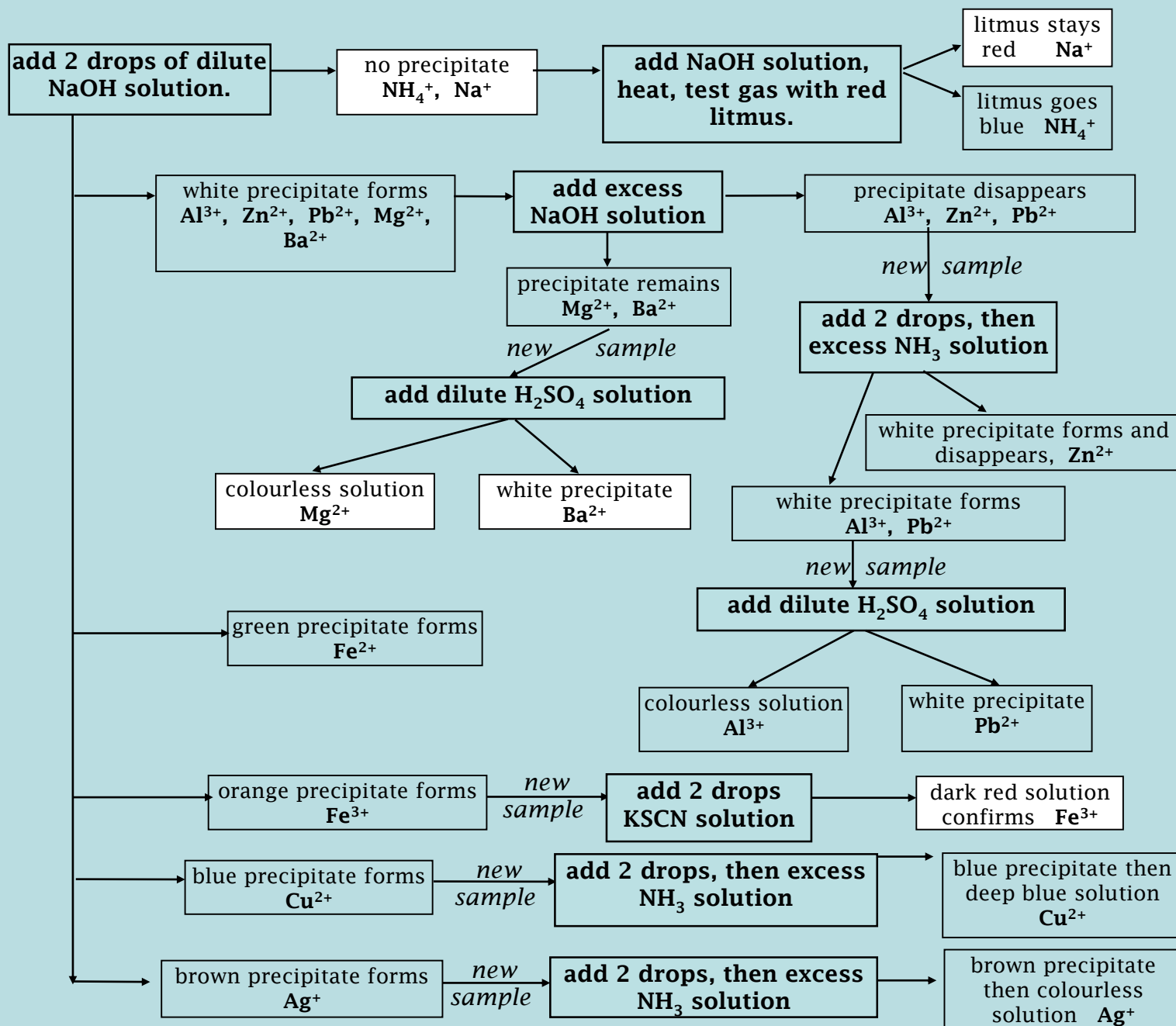
Using Aqueous Ammonia

TESTS FOR CATIONS



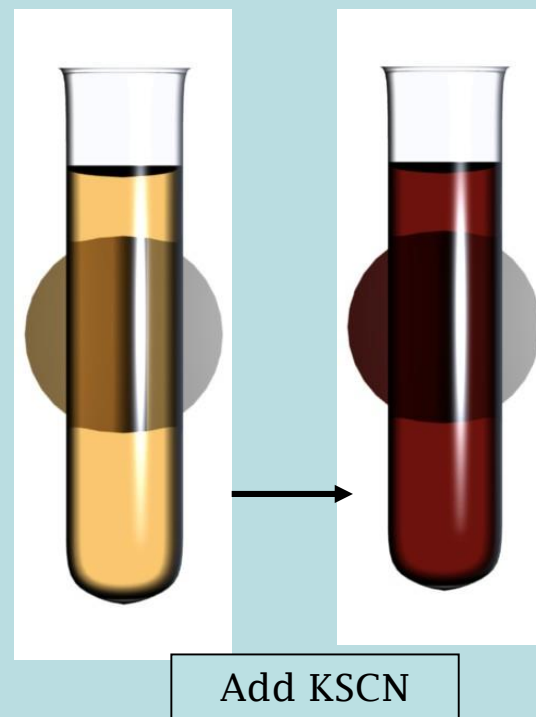
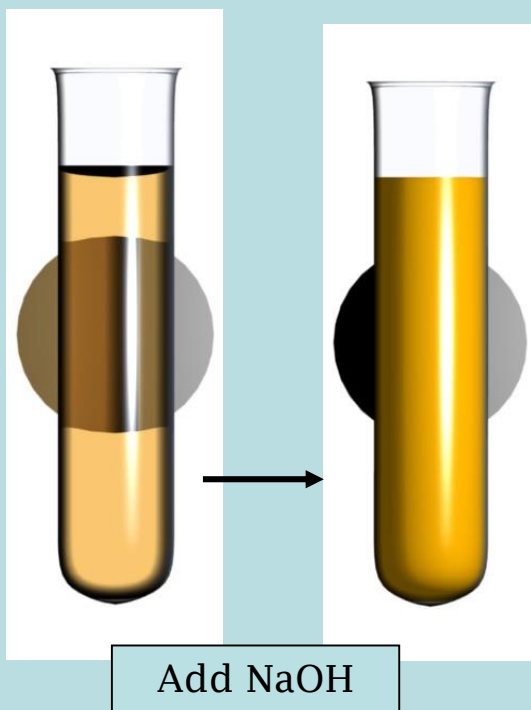
1		Very slightly White precipitate	Excess Ammonia →		Insoluble in excess	Ca^{2+}
2		White precipitate	Excess Ammonia →		Insoluble in excess	Al^{3+}
3		Blue precipitate	Excess Ammonia →		Soluble in excess giving dark blue solution	Cu^{2+}
4		Dark green precipitate	Excess Ammonia →		Insoluble in excess	Fe^{2+}
5		Red brown precipitate	Excess Ammonia →		Insoluble in excess	Fe^{3+}
6		White precipitate	Excess Ammonia →		Soluble in excess	Zn^{2+}

Identifying Cations: NH_4^+ , Na^+ , Mg^{2+} , Ag^+ , Fe^{2+} , Fe^{3+} , Cu^{2+} , Al^{3+} , Pb^{2+} , Zn^{2+} , Ba^{2+}



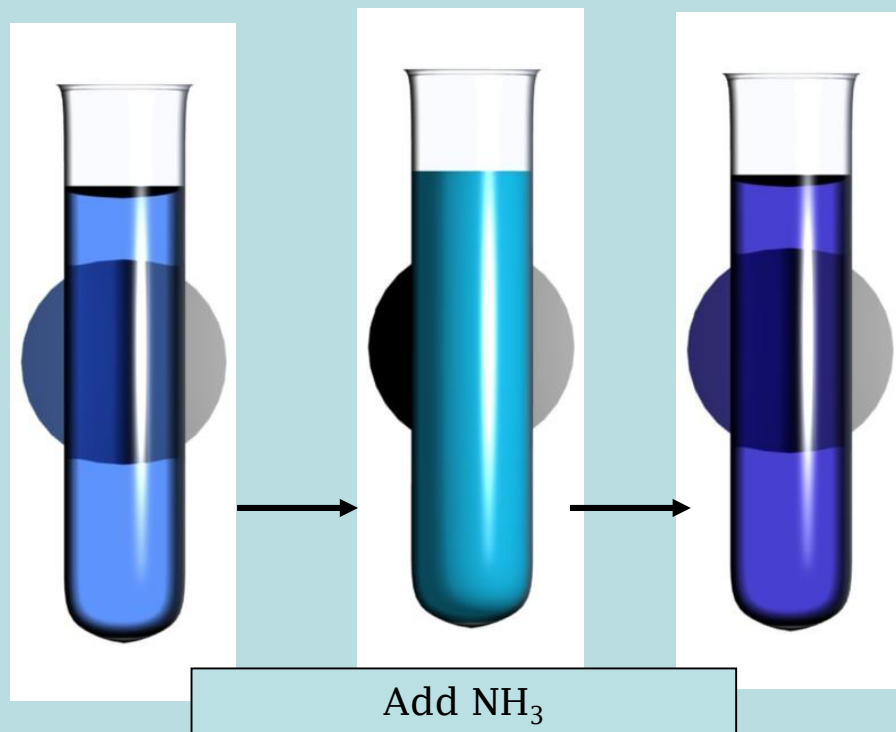
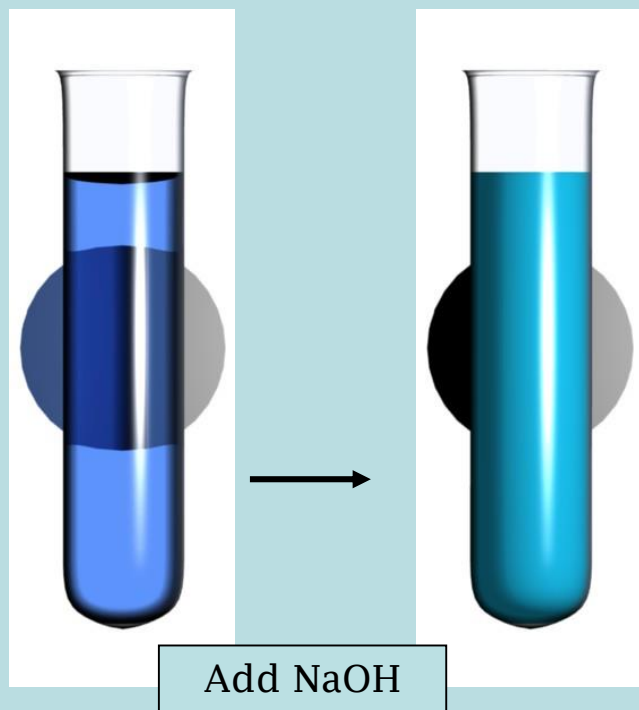
Identifying Cations I

- Use the cation flowchart to identify the cation used below:

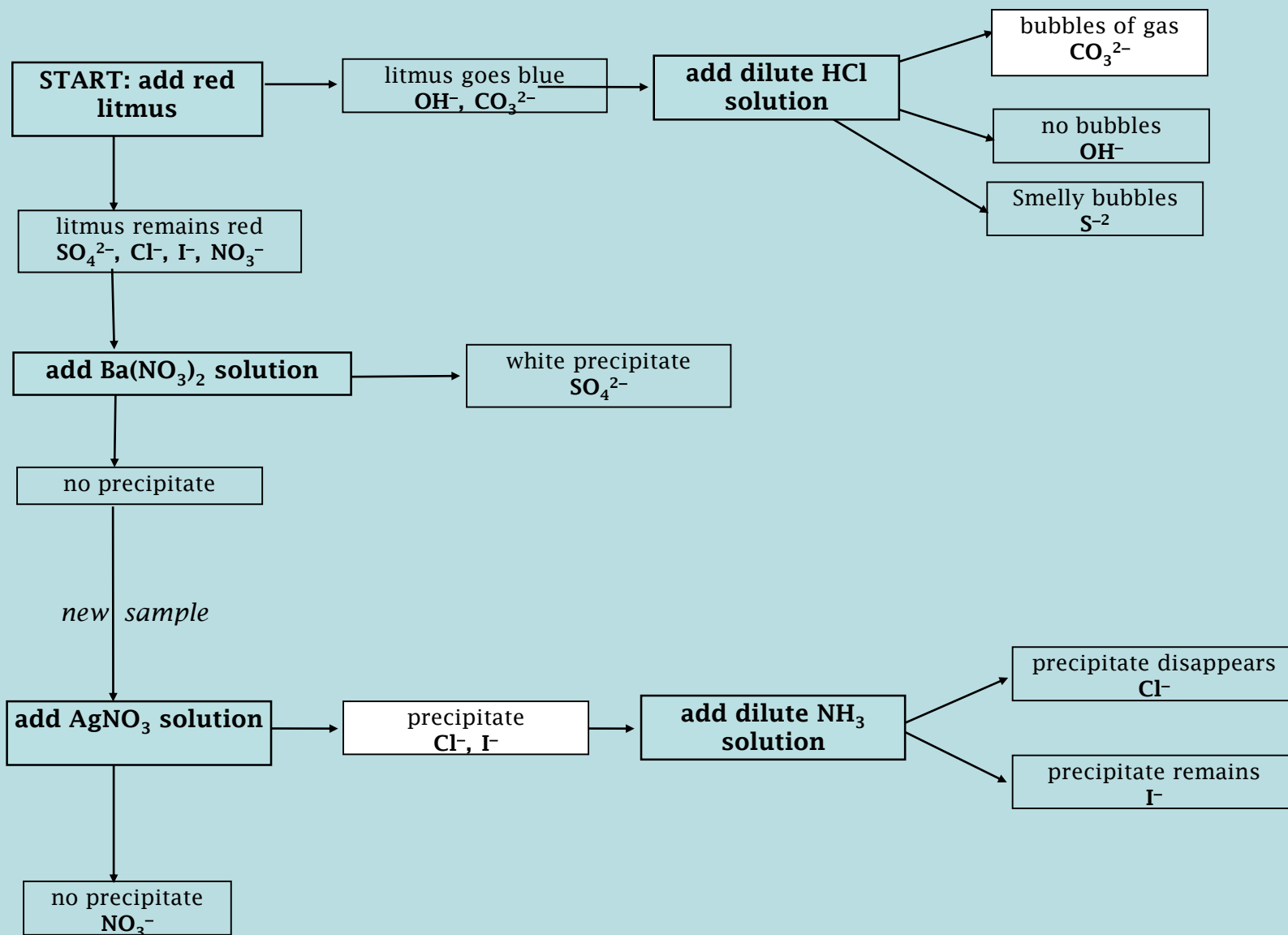


Identifying Cations II

- Use the cation flowchart to identify the cation used below:

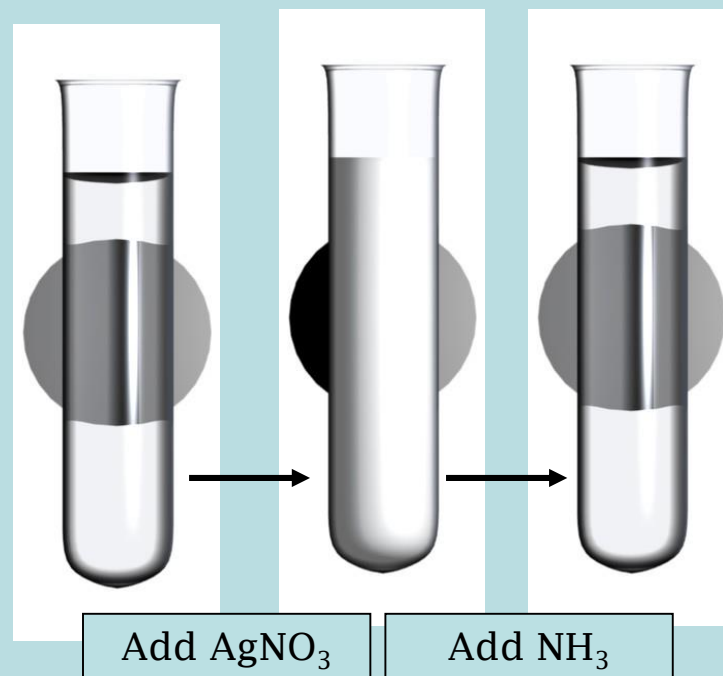
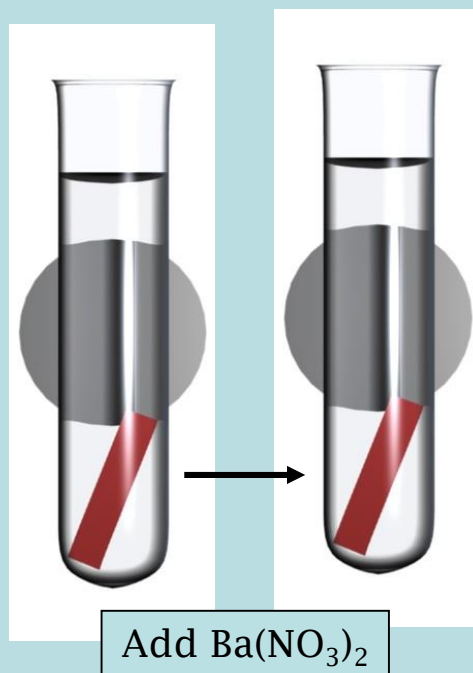
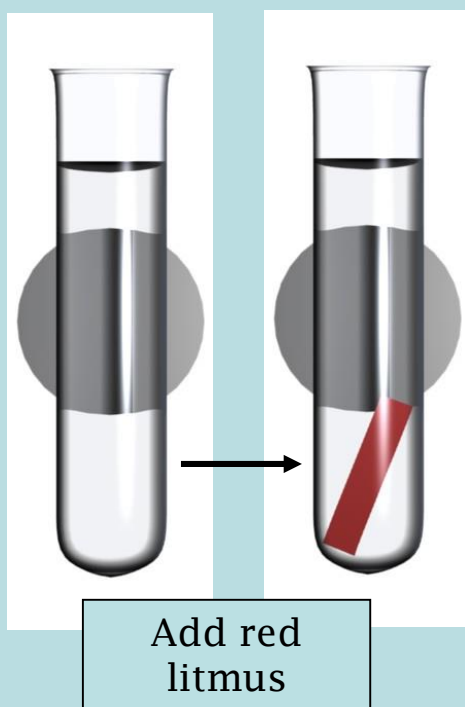


Identifying Anions: CO_3^{2-} , Cl^- , I^- , S^{2-} , SO_4^{2-} , NO_3^- , OH^-



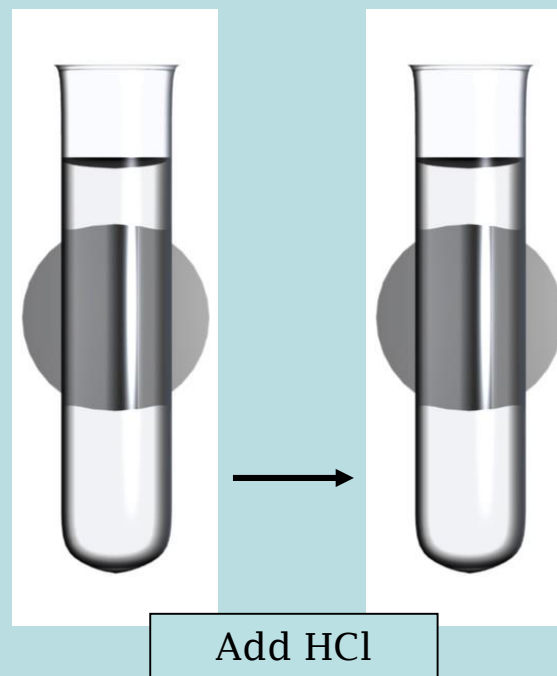
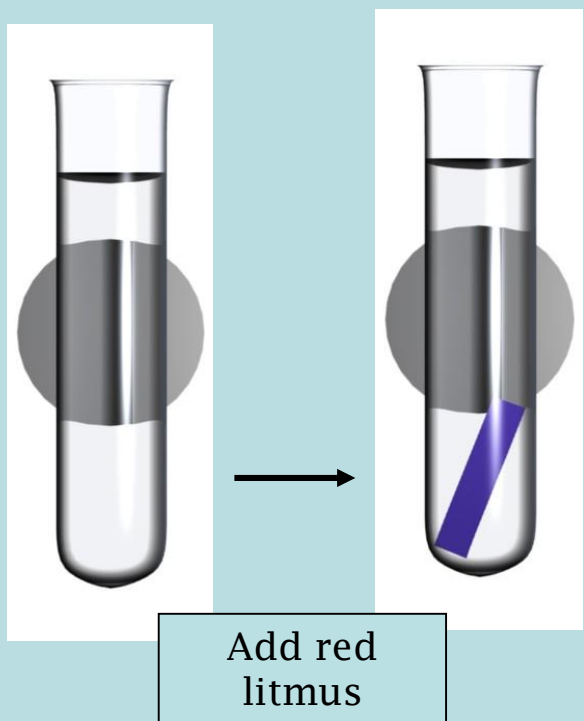
Identifying Anions I

- Use the anion flowchart to identify the anion used below:



Identifying Anions II

- Use the anion flowchart to identify the anion used below:



Solution Colors

	Ions	Symbol	Colour
Cations	Chromium(II)	Cr^{2+}	Blue
	Copper(II)	Cu^{2+}	
	Chromium(III)	Cr^{3+}	Green
	Copper(I)	Cu^{+}	
	Iron(II)	Fe^{2+}	
	Nickel(II)	Ni^{2+}	
Anions	Iron(III)	Fe^{3+}	Pale yellow
	Cobalt(II)	Co^{2+}	Pink
	Manganese(II)	Mn^{2+}	
	Chromate	CrO_4^{2-}	Yellow
	Dichromate	$\text{Cr}_2\text{O}_7^{2-}$	Orange
	Permanganate	MnO_4^{2-}	purple

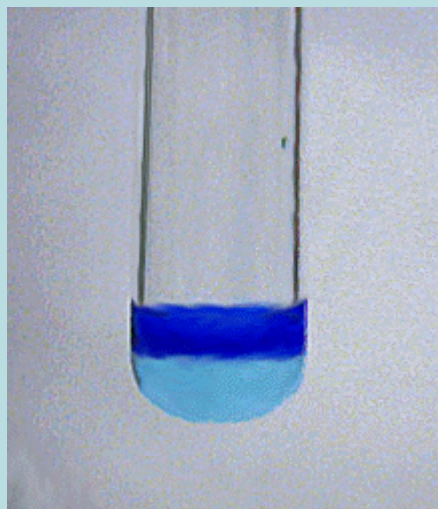
Some Precipitate Colours

Al^{3+} , Mg^{2+} , $\text{Ca}^{2+} \rightarrow$ white

$\text{Cu}^{2+} \rightarrow$ blue/green

$\text{Fe}^{2+} \rightarrow$ grey/green

$\text{Fe}^{3+} \rightarrow$ red/brown



Precipitated copper(II) hydroxide, $\text{Cu}(\text{OH})_2$



Precipitated calcium carbonate (CaCO_3)

So How Do I Use Qualitative Analysis?

- Here is an example of a question:

A sample of a solution of an unknown was treated with dilute HCl. The white precipitate formed was filtered and washed with hot water. A few drops of KI solution were added to the hot water filtrate and a bright yellow precipitate was produced. The white precipitate remaining on the filter paper was readily soluble in NH_3 solution. What two ions could have been present in the unknown?

(A) Ag^+ and Hg_2^{2+} Ask yourself - what happens at each step?

(B) Ag^+ and Pb^{2+}

(C) Ba^{2+} and Ag^+

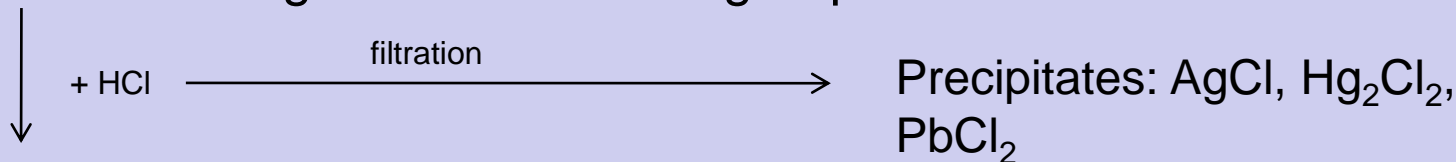
(D) Ba^{2+} and Hg_2^{2+}

(E) Ba^{2+} and Pb^{2+}

Solution - Ag^+ forms a precipitate with chlorides (AgCl), so what is the other metal? Think of a metal that would likely be insoluble with $\text{I}^- \rightarrow \text{Pb}^{2+}$ is a good choice because in our labs, it formed mostly yellow/orange precipitates.

Lab Procedures For Qualitative Analysis

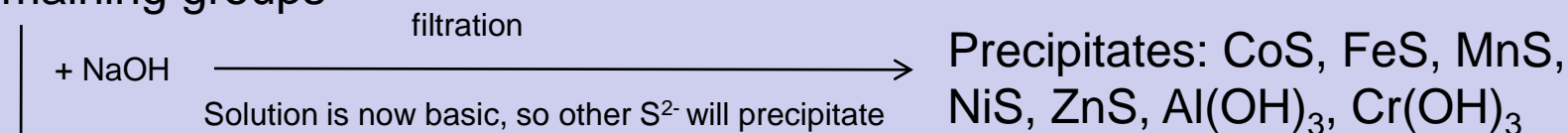
Solution containing ions of all cation groups



Solution containing ions of remaining groups



Solution containing ions of remaining groups



Solution containing ions of remaining groups



Solution contains Na⁺, K⁺, NH₄⁺ ions