Chemical Reactions of Group I Ions

The group I ions are silver Ag^{+}, mercury Hg_2^{+2} and lead Pb^{+2}. The chloride salts of these ions are insoluble, therefore, to prevent any interference with the cations of group II, hydrochloric acid is added to remove them as the chlorides:

$$Ag^{+} + Cl^{-} \longleftrightarrow AgCl\downarrow$$

White ppt.

$$Hg_2^{+2} + 2Cl^{-} \longleftrightarrow Hg_2Cl_2\downarrow$$

White ppt.

$$Pb^{+2} + 2Cl^{-} \longleftrightarrow PbCl_2\downarrow$$

White ppt.

A large excess of chloride ions must be avoided to prevent the formation of soluble silver chloride or lead chloride anions.

The Aim:

Is to teach students how to deal with laboratory glassware's, chemical reagents and observation of common colored products of chemical reactions.

Reactions of the Aqueous Solution of Hg_2^{+2} :

1) **HCl (diluted acid):**

Put few drops (2-3) of the sample solution in a test tube, add dilute HCl drop by drop till a white precipitate of Hg_2Cl_2 is formed.

$$Hg_2(NO_3)_2 + ٢HCl \longrightarrow Hg_2Cl_2\downarrow + 2HNO_3$$

This white precipitate of Hg_2Cl_2 is:

a) Insoluble in hot water and cold diluted acids.

b) Turns black when ammonia solution is added.

$$\mathbf{Hg_2Cl_2 + 2NH_3 \longrightarrow Hg(NH_2)Cl + Hg + NH_4Cl}$$

Black powder

2) Potassium chromate solution (K_2CrO_4):

Add few drops of K_2CrO_4 to few drops of the sample in a test tube, **Hg_2CrO_4** will formed as a brown precipitate which turns to red crystals on boiling.

3) Ammonia solution:

When ammonia solution is added to aqueous solution of Hg_2^{+2} a black precipitate will be formed which consists of the ammoniacal mercuric salt and fine powder of mercury.

Reactions of the Aqueous Solution of Pb^{+2}

In all of these reactions only few drops are used:

1) HCl (diluted):

On addition of diluted HCl to the aqueous solution of Pb^{+2} , a white precipitate will be formed only when the solution is cold.

$$Pb(NO_3)_2 + 2HCl \longrightarrow PbCl_2\downarrow + 2HNO_3$$

White ppt.

This precipitate dissolves in hot water but separates again as needle-like crystals when the solution is re-cooled

2) Potassium chromate solution:

It forms a yellow precipitate of **$PbCrO_4$** which is insoluble in acetic acid and ammonia solution but soluble in hydroxides and in HNO_3.

3) Sodium hydroxide:

It forms a white precipitate of **$Pb(OH)_2$** which dissolves on adding excess of **NaOH** to form Na_2PbO_2.

$$Pb(NO_3)_2 + 2NaOH \longrightarrow Pb(OH)_2\downarrow + 2NaNO_3$$

$$Pb(OH)_2 + 2NaOH \longrightarrow Na_2PbO_2 + 2H_2O$$

Reactions of the Aqueous Solution of Ag^+ :

1) HCl (diluted):

A cloudy white precipitate of **AgCl** is formed, this precipitate is insoluble in water and acids including HNO_3 but soluble in ammonia solution because it forms a complex ion.

2) Potassium chromate:

Red precipitate of **Ag_2CrO_4** is formed, insoluble in acetic acid (diluted), but soluble in diluted HNO_3 and ammonia solution.

3) Sodium hydroxide:

Brown precipitate of **Ag_2O** is formed, insoluble on addition of excess of the precipitant (NaOH solution).

$$2AgNO_3 + 2NaOH \longrightarrow Ag_2O\downarrow + 2NaNO_3 + H_2O$$

↓ = precipitate= p.p.t