BO_3^{-3}

★

$H_3BO_3 \xrightarrow{100^\circ C} HBO_2$ (Metaboronic acid)

$HBO_2 \xrightarrow{140^\circ C} H_2B_4O_7$ (tetraboronic acid)

$H_2B_4O_7 \xrightarrow[\text{temp.}]{\text{high}} B_2O_3 + H_2O$ (Pyroboronic acid)

Very few borate salts are known mainly tetraborate and metaborate salts are known.

☆ Test with acid

$$BO_3^{-3} + \text{conc.}H_2SO_4 \xrightarrow{\Delta} H_3BO_3\uparrow$$

(White fumes)

Note ⇒ Initially no visible action.

because H_3BO_3 form H-Bonding with conc.H_2SO_4

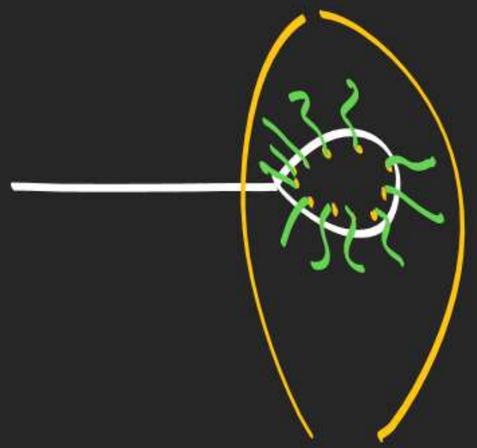
$$BO_3^{-3} + \text{conc.}HCl \longrightarrow H_3BO_3\downarrow \xrightarrow{\Delta} H_3BO_3\uparrow$$

White ppt — White fumes

Test with Conc. H_2SO_4 + CH_3OH or C_2H_5OH (flame test)

Salt + Conc. H_2SO_4 + C_2H_5OH or CH_3OH → $B(OCH_3)_3$ (Trimethyl borate) or $B(OC_2H_5)_3$ (Triethyl borate)

taken as a paste



green edge colour to the flame on touching

$BO_3^{-3} + \text{conc.}\ H_2SO_4 \longrightarrow B(OH)_3$

$B(OH)_3 + 3\,H\text{-}OCH_3 \xrightarrow[\text{(dehy. agent)}]{\text{conc.}\ H_2SO_4} B(OCH_3)_3$

Note:- Ba and Cu cation also give green flame to the flame. In this condition this test should be modified.

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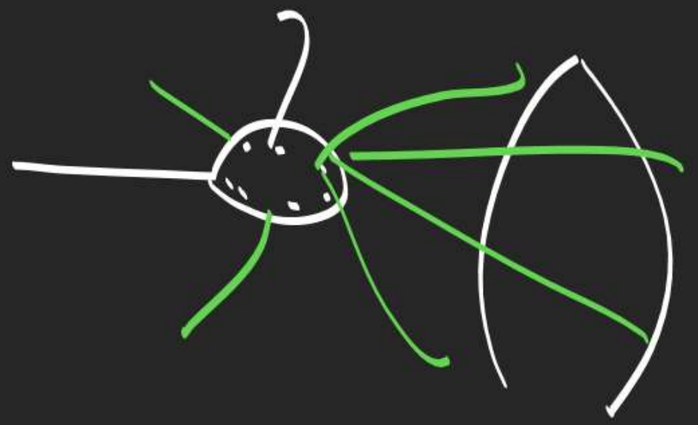
$$\text{Salt} + \underbrace{\text{Conc.}H_2SO_4 + CaF_2}_{\text{taken as Paste}} \xrightarrow{\Delta} \underline{BF_3} + NaHSO_4 + Ca(HSO_4)_2$$



extremly volatile product gives green col. to the flame without touching

In such experimental condition Ba and Cu donot give volatile product.

Test with $AgNO_3$

$$B_4O_7^{-2} + AgNO_3 \longrightarrow AgBO_2$$

($AgBO_2$: White ppt.)

Soluble in NH_4OH and CH_3COOH

$C_2O_4^{-2}$

① Test with acid

$$C_2O_4^{-2} + \text{Conc.}H_2SO_4 \longrightarrow H_2C_2O_4 \xrightarrow{\Delta} CO + CO_2 + H_2O$$

$CO \Rightarrow$ Colourless gas but burn with blue flames

$$CO + PdCl_2 + H_2O \longrightarrow Pd + CO_2 + HCl$$

Black ppt.

✱ Test with $BaCl_2/CaCl_2$

$$C_2O_4^{-2} + BaCl_2/CaCl_2 \longrightarrow BaC_2O_4/CaC_2O_4$$

White ppt.

Note ⇒ BaC_2O_4 ⇒ Soluble in CH_3COOH, $H_2C_2O_4$ and ammonium oxalate

CaC_2O_4 ⇒ Insoluble in CH_3COOH, $H_2C_2O_4$ and ammonium oxalate.

$$BaCO_3 \xrightarrow[Na_2C_2O_4]{CH_3COOH} \text{Clear solution}$$

$$CaCO_3 \xrightarrow[Na_2C_2O_4]{CH_3COOH} \text{White ppt.}$$

Test based on Redox

$$\underset{\text{White ppt}}{Ba^{+3}C_2O_4 / CaC_2O_4} + MnO_4^- + H^+ \longrightarrow \underset{\text{Pink/purple Col.}}{Mn^{+2}} + CO_2 + H_2O \quad (\text{Col. less})$$

$$\begin{cases} \underline{Fe^{+2}C_2O_4} + MnO_4^- \xrightarrow{H^+} Fe^{+3} + Mn^{+2} + CO_2 + H_2O \\ Sn^{+2}C_2O_4 + MnO_4^- \xrightarrow{H^+} Sn^{+4} + Mn^{+2} + CO_2 + H_2O \end{cases}$$

both cation and anion decolorise Col. of MnO_4^-

Test with $AgNO_3$

$$C_2O_4^{-2} + AgNO_3 \longrightarrow AgC_2O_4$$

White ppt.
Soluble in dil HNO_3 and NH_3 solution.

Test with $MnSO_4$

$$MnSO_4 + NaOH \longrightarrow Mn(OH)_2 + Na_2SO_4$$

White - Pink col.
↓ atomspheric oxygen
$MnO_2 \cdot H_2O$ or $MnO(OH)_2$ (Brown col.)
Hydrated Mag. di oxide

$$MnO(OH)_2 + C_2O_4^{-2} \longrightarrow [Mn^{+3}(C_2O_4)_3]^{-3} + CO_2$$

Red col.

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$HCOO^-$

Test with dil H_2SO_4

$$HCOO^- + dil\,H_2SO_4 \longrightarrow HCOOH$$ [Pungent smell]

$$HCOO^- + Conc.\,H_2SO_4 \longrightarrow HCOOH \xrightarrow[H_2SO_4]{Conc.} CO + H_2O$$

(H_2SO_4 ↓ dehy. agent)

Test with $AgNO_3$

$$CH_3COO^- + AgNO_3 \rightleftharpoons CH_3COOAg$$

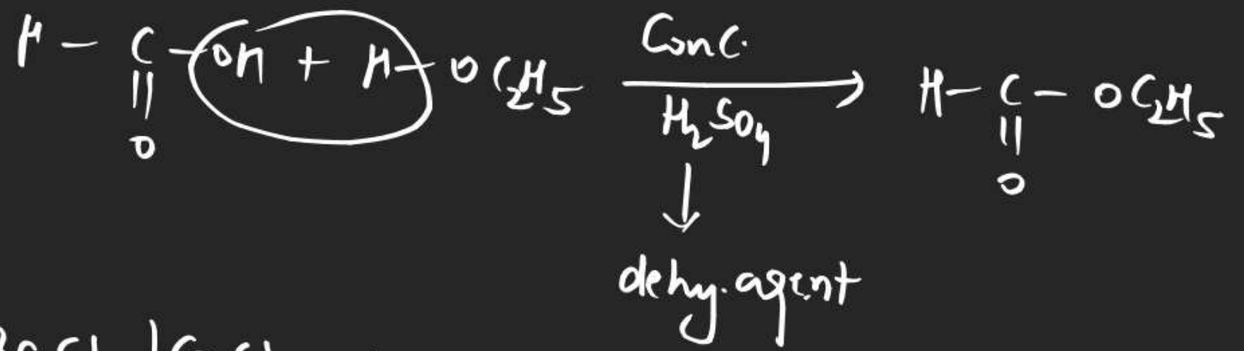
(White ppt.)

$$HCOO^- + AgNO_3 \longrightarrow HCOOAg$$ soluble on boiling

$$HCOOAg \xrightarrow{\Delta} HCOOH + Ag$$ (Metallic Black)

Test with Conc. H_2SO_4 + C_2H_5OH

$$HCOO^- + \text{Conc.}\ H_2SO_4 \longrightarrow HCOOH$$



Test with $BaCl_2$ | $CaCl_2$ → No reaction

dist. b/w (formate and $C_2O_4^{-2}$)

Test with neutral $FeCl_3$

$$HCOO^- + Fe^{+3} + H_2O \longrightarrow [Fe_3(HCOO)_6]^{+3}$$

Deep Red Colour

$$[Fe_3(HCOO)_6]^{+3} + H_2O \xrightarrow{\text{boiling}} Fe(OH)_2CH_3COO + HCOOH$$

Brown ppt

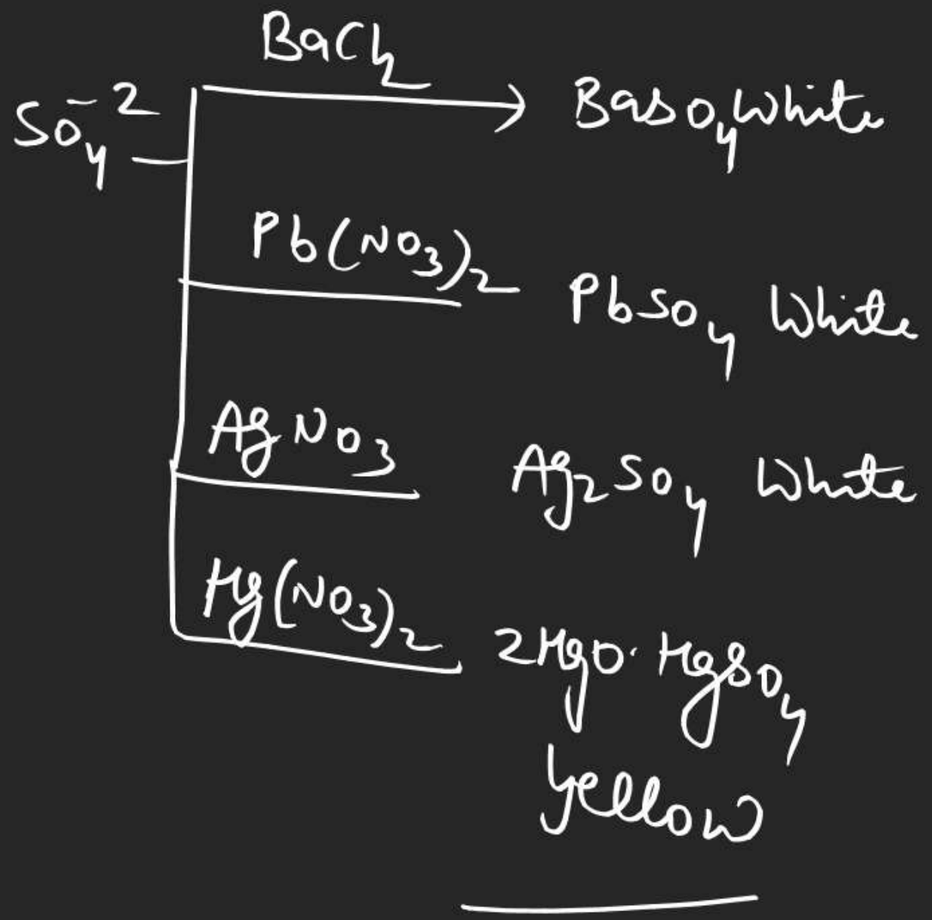
Test $HgCl_2$

$$HgCl_2 + HCOO^- \longrightarrow Hg_2Cl_2 + Cl^- + CO + CO_2 + H_2O$$

$$Hg_2Cl_2 + HCOO^- \longrightarrow Hg + Cl^- + CO + CO_2 + H_2O$$

Class - B

(1) Sub group - I



$BaSO_4$ ⇒ it is insoluble in any acid base
but soluble in hot Conc. HCl and Conc. H_2SO_4

$PbSO_4$ ⇒ soluble in hot and Conc H_2SO_4, ammonium acetate
ammonium tartarte and excess NaOH

Test with $BaCl_2$ in presence of MnO_4^- sol.

$SO_4^{-2} + BaCl_2 \xrightarrow[\text{of } MnO_4^- \text{ solution}]{\text{In presence}}$ $BaSO_4$ (Pink PPt)

because white ppt $BaSO_4$ adsorb some MnO_4^- ion

$\downarrow H_2O_2$

Clear Pink PPt of $BaSO_4$ observed because MnO_4^- of solution decol. but not adsorbed MnO_4^-

PO_4^{-3}

☆ (1) Test with $(NH_4)_2MoO_4$ in presence of HNO_3

$$PO_4^{-3} + Conc.HNO_3 + (NH_4)_2MoO_4 \xrightarrow{T \leq 40^\circ C} (NH_4)_3PO_4 \cdot 12MoO_3$$

Canary yellow ppt.

$(NH_4)_3 P\, Mo_{12} O_{40}$

$(NH_4)_3 P (Mo_3 O_{10})_4$

Note ⇒ temp. should be equal to or less than 40°C because similar yellow ppt. is given by AsO_4^{-3} also

Why Conc. HNO_3 added first

Ans ⇒ Sometimes Reducing ions may also present in the solution like S^{-2} SO_3^{-3}

$$S^{-2} / SO_3^{-2} + Mo^{+6} \longrightarrow \underset{\text{Blue ppt}}{Mo_3O_8 \cdot x H_2O}$$

So in presence of HNO_3 they will oxidised and don't interfer the test

★ Test with $FeCl_3$

$$PO_4^{-3} + FeCl_3 \longrightarrow FePO_4$$

yellowish-white

Soluble in dil HNO_3 / dil HCl

but insoluble CH_3COOH

Test with magnesia mixture

$$PO_4^{-3} + \underbrace{MgCl_2 + NH_4OH + NH_4Cl} \longrightarrow Mg(NH_4)PO_4 \text{ (white ppt.)}$$

$$\downarrow \Delta$$

$$Mg_2P_2O_7 + NH_3 + H_2O$$

(White ppt.)