ANALYSIS OF ANIONS

The classification of anions is based on their reactions with two ions: Ag^+ and Ba^{2+} . Reagents used for anion classification are: 0.1M $AgNO_3$ and 0.1M $Ba(NO_3)_2$

Classification of anions

Group	Anions	Reaction with:	
		$AgNO_3$	$Ba(NO_3)_2$
I	Cl^-, Br^-, I^-, SCN^-	white or yellow precipitate	no precipitate
II			
III	CO_3^{2-},	white precipitate	white precipitate
IV	HPO_4^{2-}	color precipitate	white precipitate
V	NO_3^-	no precipitate	no precipitate
VI	SO_4^{2-}	no precipitate	white precipitate

GROUP I ANIONS

Group I: anions: Cl^-, Br^-, I^-, SCN^- (chloride, bromide, iodide, thiocyanate)

1. Reactions with the group reagents

1° Put 2-3 drops of each of group I anions into separate test tubes. To each tube add 2-3 drops of $AgNO_3$ solution. Precipitates will form in all tubes.

$$Cl^- + AgNO_3 \rightarrow AgCl\downarrow + NO_3^-$$

Observe the color of these precipitates.

2° Add a few drops of $Ba(NO_3)_2$ solution to the test tubes prepared as before. Precipitates will not form.

2. Characteristic reactions

2.1.Reactions with chlorine water

To the 4 tubes with group I anions add a pipete of chlorine water (an aqueous solution of chlorine) and 2-3 ml of chloroform (chloroform does not mix with water and goes down because is heavier than water). Shake the contents of a test tube energetically. Observe the color of the chloroform layers.
Chlorine oxidizes bromide and iodide ions to free bromine and iodine (redox reaction), well soluble in apolar organic solvents:

$$Cl_2 + 2Br^- \longrightarrow 2Cl^- + Br_2$$

$$Cl_2 + 2I^- \longrightarrow 2Cl^- + I_2$$

2.2. Reaction with $FeCl_3$

Add a few drops of $FeCl_3$ to a few drops of group I anions in separate tubes. This reaction is characteristic for SCN^- (thiocyanate) ions. Observe the color.

$$Fe^{3+} + 3SCN^- \rightarrow Fe(SCN)_3$$

GROUP III ANIONS

Group III anion: CO_3^{2-} (carbonate)

1. Reactions with group reagents

1° Put 2-3 drops of CO_3^{2-} into a test tube and add a few drops of $AgNO_3$. Observe the color of the precipitate.

$$CO_3^{2-} + 2Ag^+ \longrightarrow \underline{Ag_2CO_3}$$

This white precipitate turns yellow, then brownish-black when heated:

$$\underline{Ag_2CO_3} + H_2O \longrightarrow \underline{Ag_2O} + CO_2 + H_2O$$

2° Put 2-3 drops of CO_3^{2-} into a test tube and add a few drops of $Ba(NO_3)_{22}$ .Observe the color of the precipitate.

2. Characteristic reactions

2.1. Reaction of CO_3^{2-} anion with strong acids

Add 2M HNO_3 drop by drop to 2-3 ml of CO_3^{2-} solution and observe bubbles of CO_2 :

$$CO_3^{2-} + 2H^+ \longrightarrow H_2CO_3 \longrightarrow CO_2\uparrow + H_2O$$

GROUP IV ANIONS

Group IV anion: HPO_4^{2-} (phosphate)

1. Reactions with group reagents

1° Put 2-3 drops of HPO_4^{2-} into a test tube and add a few drops of $AgNO_3$. Observe the color of the precipitate.

$$HPO_4^{2-} + AgNO_3 \rightarrow Ag_2HPO_4 + NO_3^-$$

2° Put 2-3 drops of HPO_4^{2-} into a test tube and add a few drops of $Ba(NO_3)_2$ .Observe the color of the precipitate.

2. Characteristic reactions

2.1. Reaction of HPO_4^{2-} ion with magnesia mixture

Prepare the magnesia mixture (an aqueous solution of $MgCl_2$, NH_3 and NH_4Cl) mixing 5 drops of each. Add a few drops of HPO_4^{2-} solution. Observe the color of the precipitate.

$$Mg^{2+} + HPO_4^{2-} + NH_3 \longrightarrow \underline{MgNH_4PO_4}$$

GROUP V ANIONS

Group V anion: NO_3^- (nitrate)

1. Reactions with group reagents

1° Put 2-3 drops of NO_3^- into a test tube and add a few drops of $AgNO_3$.

2° Put 2-3 drops of NO_3^- into a test tube and add a few drops of $Ba(NO_3)_2$.

2. Characteristic reactions

2.1. Reaction of nitrate ion with $FeSO_4$ ("ring" reaction)

Put a few crystals of $FeSO_4$ into a test tube and add about 1 ml of distilled water. Shake the contents of the test tube. Add an equal amount of NO_3^- solution. Shake again and carefully add concentrated H_2SO_4. Do not shake the tube. Brown ring of complex ion $Fe(NO)^{2+}$ appears on the border between two solutions:

$$3Fe^{2+} + NO_3^- + 4H^+ \longrightarrow 3Fe^{3+} + NO\uparrow + 2H_2O$$

$$Fe^{2+} + NO \rightleftharpoons Fe(NO)^{2+}$$

GROUP VI ANIONS

Group VI anion: SO_4^{2-} (sulfate)

1. Reactions with group reagents

1° Put 2-3 drops of SO_4^{2-} into a test tube and add a few drops of $AgNO_3$. Reaction does not occur.

2° Put 2-3 drops of SO_4^{2-} into a test tube and add a few drops of $Ba(NO_3)_2$. Observe the color of the precipitate.

$$Ba^{2+} + SO_4^{2-} \longrightarrow \underline{BaSO_4}$$