Anions Analysis Lab Notes

FLOW DIAGRAMS

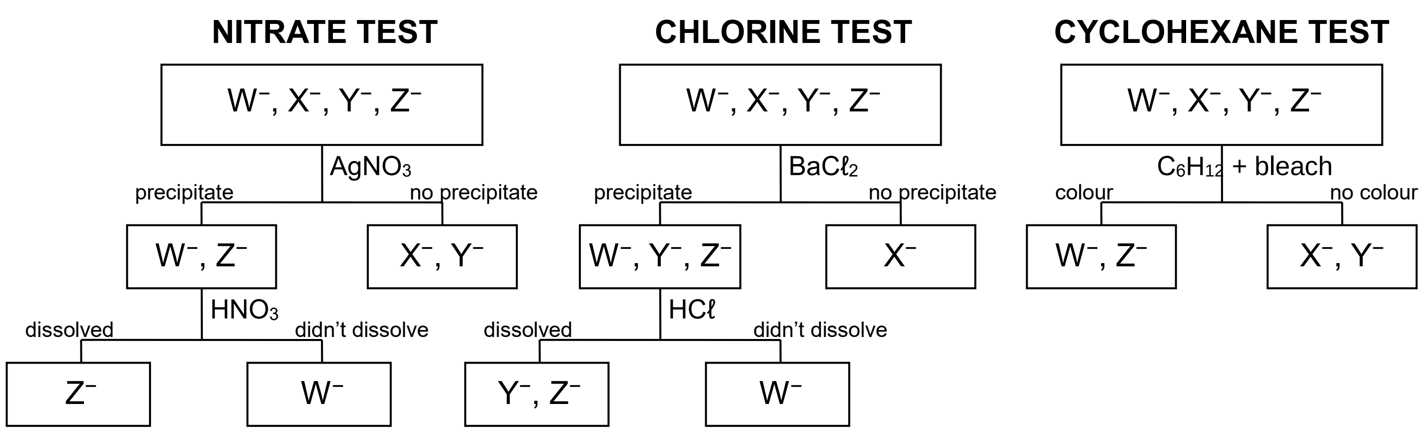
A flow diagram will convey the same information as a data table, but does so in a more meaningful way. The diagram illustrates, sequentially, the tests that were performed and their results. More importantly, it groups together those anions which behave similarly and separates those which do not.

Consider the following *hypothetical* example:

Table:

	TEST A		TEST B		TEST C
ANION	$AgNO_3$	HNO_3	$BaC\ell_2$	$HC\ell$	cyclohexane
W^-	ppt	did not dissolve	ppt	did not dissolve	blue
X^-	no ppt	- - -	no ppt	- - -	colourless
Y^-	no ppt	- - -	ppt	dissolved	colourless
Z^-	ppt	dissolved	ppt	dissolved	green

Flow diagram:



Then, if you are given a solution containing either X^- or Y^- ions, you could use your flow diagram to determine which one it contained. Since several tests may yield similar results, it is necessary to choose the right test. Here, both the nitrate and cyclohexane tests produce identical results for X^- and Y^-, so performing either of these tests would not allow you to distinguish between the two anions. However, the $BaC\ell_2$ test could be used to identify whether anion X^- or Y^- is present. With the addition of $BaC\ell_2$, either a precipitate forms (which dissolves in $HC\ell$) or it doesn't. If there is a precipitate, Y^- must be present; if there isn't a precipitate, we conclude X^- must be present.

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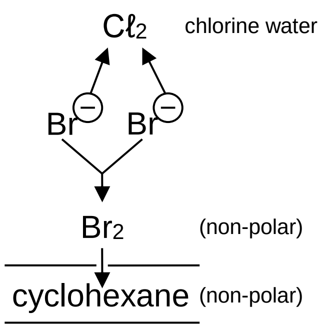
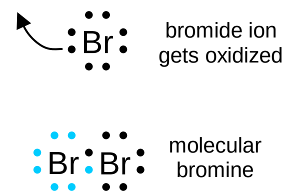
THE CYCLOHEXANE TEST

Subtle colour distinctions are often inadequate to confirm the presence of a particular halide ion ($C\ell^-$, Br^-, or I^-). With the addition of chlorine water ($C\ell_2$ dissolved in water) and cyclohexane, these distinctions become more noticeable.



Chlorine water oxidizes bromide ions (Br^-) to molecular bromine (Br_2) and iodide ions (I^-) to molecular iodine (I_2). In other words, chlorine water removes an electron from each Br^- ion, thus facilitating the formation of Br_2; similarly, chlorine water removes an electron from each I^- ions, facilitating the formation of I_2. Note that Br^- contains eight electrons in its valence shell, and the removal of one electron is required for it to form diatomic bromine — the chlorine water is responsible for the removal of electrons.



The resulting halogen species (Br_2, I_2) are diatomic and non-polar. These species, being non-polar, will prefer to dissolve in a solvent of similar nature; hence, the use of cyclohexane (a non-polar solvent). This follows from the “like dissolves like” rule: polar substances tend to dissolve in polar solvents, and non-polar substances tend to dissolve in non-polar solvents.

Upon dissolving, each halogen species imparts its characteristic colour to the cyclohexane layer (see Halogens in your textbook for more information). The colours produced are distinctly different ($C\ell_2$ is pale yellow; Br_2 is yellow-orange to reddish-brown, and I_2 is pink to violet) and constitute positive tests for Br^- and I^- ions in the original solution.

The cyclohexane test is not conclusive for $C\ell^-$ since $C\ell_2$ was used as the reagent. The pale yellow colour characteristic of $C\ell_2$ will be apparent in the cyclohexane layer even if no chloride oxidation occurs in the aqueous layer.

ADDITIONAL NOTES

→ Note that silver sulfate (Ag_2SO_4) did not precipitate in this experiment but the solubility tables say otherwise. The concentration levels used in this experiment were not sufficient to permit precipitation.

→ In this experiment, sodium hypochlorite is used to supply the $C\ell_2$ necessary for the oxidation (loss of electrons).

→ Br_2 and I_2 are non-polar because there is an equal sharing of the bonded pair within each molecule. (Obviously, the difference in electronegativities between the atoms is exactly zero.)

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