The content on this sheet is assessed on paper 2 only.

Topic 9a—Qualitative analysis: tests for ions

* Indicates that these are some examples only: you could be asked about any substance / reaction.

9.1—Unique tests

It is important that tests for ions are unique, to ensure that the results are not inconclusive.

9.2—Flame tests

Match up the metal ion to the correct flame test colour.

a) Lithium ion, Li^+	Red	~~Blue-green~~
b) Sodium ion, Na^+	Yellow	~~Lilac~~
c) Potassium ion, K^+	Lilac	~~Orange-red~~
d) Calcium ion, Ca^{2+}	Orange-Red	~~Red~~
e) Copper (II) ion, Cu^{2+}	Blue-green	~~Yellow~~

9.3—Adding sodium hydroxide to test for ions in solution

Match up the metal ion to the correct coloured precipitate formed.

a) Aluminium ion, Al^{3+}	White	~~Blue~~
b) Calcium ion, Ca^{2+}	White	~~Brown~~
c) Copper (II) ion, Cu^{2+}	Blue	~~Green~~
d) Iron (II) ion, Fe^{2+}	Yellow	~~White~~
e) Iron (III) ion, Fe^{3+}	Brown	~~White~~

The positive result for the aluminium ion and the calcium ion are the same, so a further test is required. When further sodium hydroxide is added, the aluminium hydroxide dissolves, whereas the calcium hydroxide doesn't.

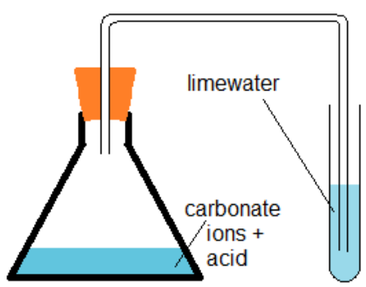
f) Add sodium hydroxide to a solution and heat it. If ammonia gas is given off, then ammonium ions were present in the solution.

9.4—Testing for ammonia

Hold a piece of damp red litmus paper over the gas. If it turns blue, then ammonia is present.

9.5a—Testing for carbonate ions

To test for carbonate ions, add the solid or solution to an acid, and bubble the resulting gas through limewater. If it was a carbonate, the gas made is carbon dioxide and the limewater will turn cloudy.



9.5b—Testing for sulfate ions

To test for sulfate ions, add the solution to some dilute hydrochloric acid, and then add some barium chloride solution. If a white precipitate appears, the ion was sulfate.

The acid is needed to react with any carbonate ions that would also form a barium salt precipitate, and therefore give a false result. For the same reason, we cannot use sulfuric acid, as it contains sulfate ions.

9.5c—Testing for halide ions

To test for halide ions, add the solution to some dilute nitric acid, and then add some silver nitrate solution. If a precipitate appears, the ion was a halide.

Match up the halide ion to the correct coloured precipitate.

Chloride ion, Cl^-	White	~~Cream~~
Bromide ion, Br^-	Cream	~~White~~
Iodide ion, I^-	Yellow	~~Yellow~~

The acid is added to remove any carbonate ions, which would react with the silver ions to give a precipitate of silver carbonate.

9.6—CP7—Identifying ions

You will need to describe how to carry out a series of the tests detailed in sections 9.2-9.5 to identify the formula of a compound (see 9.7).

9.7—Identify unknown ions

A compound in a flame test produces a yellow flame. When nitric acid is added, nothing happens. A small amount of silver nitrate solution is added, and a white precipitate forms. This suggests that the compound was sodium chloride.

A compound in a flame test produced no coloured flame. Sodium hydroxide was added to the solution of this compound, upon which a white precipitate formed, which dissolved when further sodium hydroxide was added. In a separate test, dilute hydrochloric acid was added to the compound, and no changes were observed. Barium chloride was then added to the solution, upon which a white precipitate was formed. The results from the above tests suggest that the unknown compound was aluminium sulfate.

9.8—Instrumental methods of analysis

Instrumental methods of analysis are preferable to chemical methods, as they are:

Faster— tests take less time to carry out.

More sensitive— smaller samples of chemical are needed for the tests.

More accurate— the true identity of the substance is identified more readily.

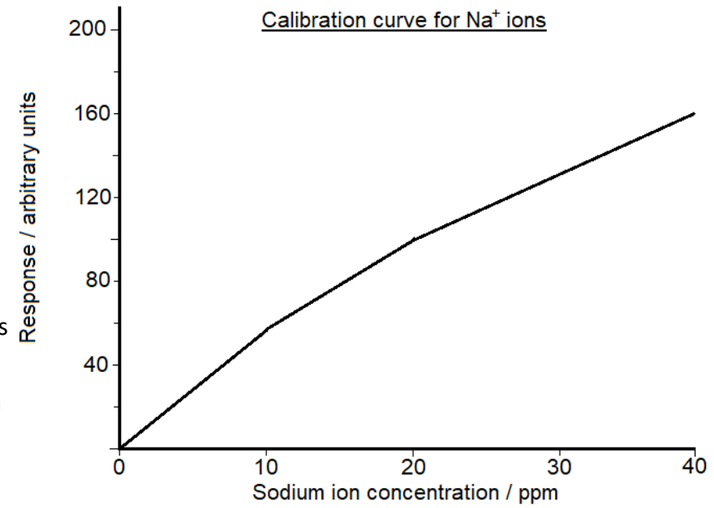
9.9a—Flame photometry & concentration curves*

Calibration curves can be used to indicate the concentration of ions in a sample.

We can then use the calibration curve to identify the unknown concentration of a sample.

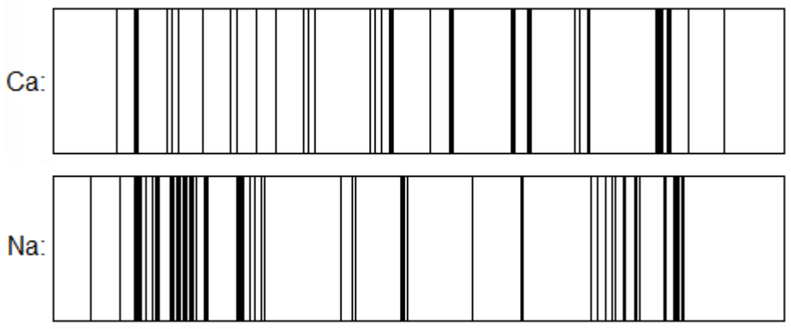
A sample of unknown concentration, known to contain Na^+ ions, gave a response of 140. This would indicate an approximate concentration of sodium ions of 32 / 33 ppm.

A second sample was known to contain 15 ppm of Na^+ ions. The expected response for this sample would be approximately 78.



9.9a—Flame photometry & spectra*

As with calibration curves, we can use sample data as a reference, and compare the spectra of unknown elements to be able to identify them. The spectra below are of calcium and sodium.



The spectrum below is likely to be of a sample containing sodium metal.