Tests for Cations and Anions – Practical

Procedure:

All chemical concentrations from Pearson, AQA Chemistry Lab Book, May 2016

Carbonate:

- Place about 2cm³ of 0.02 mol dm^{-3} limewater in a test tube with a plastic pipette (~3cm³ max). Place this test tube in a test tube rack
- Take another test tube and add 2cm³ of 0.5 mol dm^{-3} of sodium carbonate solution again with a plastic pipette
- Submerge the non-bunged end of the delivery tube in the limewater and place the other end very close to the tube with the sodium carbonate (so that you can quickly place it over the tube so not to lose too much carbon dioxide)then add 2cm³ of 0.5 mol dm^{-3} of hydrochloric acid with a plastic pipette before quickly sealing the bung on the test tube
- Record observations, a positive result causes the solution to turn cloudy due to the deposition of calcium carbonate (BBC Bitesize, Gas chemistry, Reactions of carbon dioxide)

Sulfate:

- Add 1cm³ of 0.1 mol dm^{-3} magnesium sulfate solution using a plastic pipette
- Add 1cm³ of 0.5 mol dm^{-3} hydrochloric acid and 1cm³ of 0.1 mol dm^{-3} barium chloride solution (also using a plastic pipette)
- Record observations, a positive result is a white precipitate which is the barium sulfate (Jim Clark, Testing for negative ions, 2020)

Hydroxide:

- Dip a strip of damp litmus paper into a small volume of 0.4 mol dm^{-3} sodium hydroxide solution
- Record observations, a positive result would be the litmus paper turning blue as its dipped in the solution due to it being alkali (I find this fact self evident and not requiring a source but if you insist I have provided one)

Ammonium:

- Drop 10 drops of 0.1 mol dm^{-3} ammonium chloride solution into a test tube
- Add 10 drops of 0.4 mol dm^{-3} sodium hydroxide solution, place a bung on top of the test tube and shake the mixture
- Gently warm the test tube in a water bath
- Place the tube in a test tube stand and remove the bung, hold damp red litmus paper over the mouth of the test tube using forceps

- Record observations, a positive result turns damp red litmus paper blue (Jim Clark, Testing for positive ions, 2020)
- Note: it's best not to let the litmus paper fall into the test tube if the ammonium chloride and sodium hydroxide aren't fully reacted since sodium hydroxide also turns red litmus paper blue which could cause a false positive

Group 2 Metals (sodium hydroxide):

- Place about ten drops of 0.1 mol dm^{-3} barium chloride solution in a test tube
- Add about ten drops of 0.4 mol dm^{-3} sodium hydroxide solution and mix well by gently rotating the test tube
- Continue to add sodium hydroxide until it is in excess mixing as you go
- Repeat with strontium chloride, magnesium chloride and calcium bromide in place of barium chloride, record observations, a positive result depends on the metal. For aluminium, calcium, magnesium, copper(II) iron(II) and iron(III) the results are white (but redissolves in excess sodium hydroxide), white, white, blue, green and brown respectively (BBC Bitesize, Metal hydroxide precipitate tests)

Group 2 Metals (sulfuric acid):

- Place about ten drops of 0.1 mol dm^{-3} barium chloride solution in a test tube
- Add about ten drops of 1 mol dm^{-3} sulfuric acid and mix well by gently rotating the test tube
- Continue to add sulfuric acid until it is in excess mixing as you go
- Repeat with strontium chloride, magnesium chloride and calcium bromide in place of barium chloride, record observations, a positive result is dependent on the metal due to forming different metal sulfates. In the case of magnesium it will result in a colourless solution, in the case of barium, strontium and calcium it will result in a white precipitate. (Jim Clark, REACTIONS OF THE GROUP 2 ELEMENTS WITH COMMON ACIDS, December 2021)

Halide ions (solid salts):

- It's important to carry this experiment out in a fume cupboard and wear gloves at all times
- Put a spatula of solid potassium chloride in a test tube
- Add three drops of 1 mol dm^{-3} sulfuric acid
- Repeat with potassium iodide and potassium bromide, record observations, a positive result depends on the halide ion. For chlorides the white hydrogen chloride fumes are released, for bromides colourless fumes of sulfur dioxide mixed with brown bromine vapour are released and for iodides a mix of gases including colourless fumes of hydrogen sulfide and iodine vapour is released and black iodine is produced (Jim Clark, THE REDOX REACTIONS BETWEEN HALIDE IONS AND CONCENTRATED SULPHURIC ACID, March 2022)

- To test for chlorine, iodine and bromine use moist blue litmus paper (bleaches in the presence of chlorine), filter paper dipped in 0.1 mol dm^{-3} lead nitrate solution (yellow precipitate) and filter paper dipped in 0.05 mol dm^{-3} acidified potassium dichromate solution (green solution) respectively.

Halide ions (in aqueous solution):

- Place about 10 drops of 0.1 mol dm^{-3} potassium chloride solution in a test tube
- Add Five drops of 0.1 mol dm^{-3} nitric acid, mix well by gently rotating the test tube
- Add 2 mol dm^{-3} ammonia solution and excess and shake to mix well (ensure a bung is placed on top of the test tube securely beforehand)
- Repeat using potassium bromide and potassium iodide in place of the potassium chloride, record observations, a positive result depends on the specific ion. Chloride, bromide and iodide produce white, cream and yellow precipitates respectively (Neil Goalby, Practical Guide AQA, 2023)
- After each test discard the contents of the tube

Risk Assessment:

Hazardous chemical being used or made or hazardous procedure or equipment	**Nature of the hazard(s)**	**Source(s) of information**	**Control measures to reduce the risks**	**Emergency procedure**
Sulfuric acid	Corrosive, Toxic	CLEAPSS	Only use a low concentration, wear eye protection	Calmly move to the tap and rinse the affected area, if it gets in the eyes wash eyes with the eyewash kit
Sodium Hydroxide	Corrosive, Irritant	CLEAPSS	Only use a low concentration, wear eye protection	Calmly move to the tap and rinse the affected area, if it gets in the eyes wash eyes with the eyewash kit

Hydrochloric Acid	Corrosive, Toxic, irritant	CLEAPSS	Only use a low concentration, wear eye protection	Calmly move to the tap and rinse the affected area, if it gets in the eyes wash eyes with the eyewash kit
Ammonia	Corrosive, Toxic, Hazardous to the environment	CLEAPSS	Produce in a fume cupboard (if it's high enough concentration but it isn't), wear eye protection (it's nigh impossible to not release into the environment)	If it irritates eyes wash eyes with the eyewash kit
Hydrogen Sulfide	Flammable, Toxic, Hazardous to the environment	CLEAPSS	Produce in a fume cupboard, wear eye protection, avoid producing near open flames or sparks (it's nigh impossible to not release into the environment)	If it irritates eyes wash eyes with the eyewash kit, if it (in a very unlikely set of circumstances) catches fire extinguish with sand
Sulfur Dioxide	Corrosive, Toxic	CLEAPSS	Produce in a fume cupboard	If it irritates eyes wash eyes with the eyewash kit
Iodine (Vapour)	Toxic, Irritant	CLEAPSS	Produce in a fume cupboard	If it irritates eyes wash eyes with the eyewash kit
Bromine	Toxic, Irritant	CLEAPSS	Produce in a fume cupboard	If it irritates eyes wash eyes with the eyewash kit

Sources:

John Kavanagh, Pearson, AQA Chemistry Lab Book, May 2016

BBC Bitesize, Gas chemistry, Reactions of carbon dioxide, https://www.bbc.co.uk/bitesize/guides/znwh8xs/revision/8

Jim Clark, Testing for negative ions, 2020, https://www.chemguide.uk/14to16/analysis/anions.html

Red litmus paper really does turn blue in alkali! observe: https://www.sciencephoto.com/media/1208006/view/litmus-paper-in-alkali-and-acid

Jim Clark, Testing for positive ions, 2020, https://www.chemguide.uk/14to16/analysis/cations.html

BBC Bitesize, Metal hydroxide precipitate tests, https://www.bbc.co.uk/bitesize/guides/zxtvw6f/revision/2

Jim Clark, REACTIONS OF THE GROUP 2 ELEMENTS WITH COMMON ACIDS, December 2021, https://www.chemguide.co.uk/inorganic/group2/reactacids.html

Jim Clark, THE REDOX REACTIONS BETWEEN HALIDE IONS AND CONCENTRATED SULPHURIC ACID, March 2022, https://www.chemguide.co.uk/inorganic/group7/halideions.html

Neil Goalby, Practical Guide AQA, October 2023, https://chemrevise.org/wp-content/uploads/2023/10/practical-guide-aqa.pdf

All hazard information: Consortium of Local Education Authorities for the Provision of Science Services (CLEAPSS), https://science.cleapss.org.uk/resource-info/handbook-section-7-chemical-safety.aspx