Edexcel Chemistry A-level

Practical 7 and 15

Analysis of unknown inorganic and organic compounds.

Inorganic

Test for acid or base character

- Use an indicator paper.
- red = acid
- blue = base

Flame tests for Group I and Group II metal cations

- Dip a nichrome metal wire in the solution of HCl and then into the tested metal ion solution.
- Carefully place the wire at the top of the flame coming from Bunsen burner.
    - Li^+ = red
    - Na^+ = orange/yellow
    - K^+ = lilac
    - Rb^+ = red
    - Cs^+ = blue
    - Mg^{2+} = no colour
    - Ca^{2+} = brick-red
    - Sr^{2+} = crimson red
    - Ba^{2+} = green

CO_3^{2-} and HCO_3^- ions

- Add aqueous acid.
- Bubbles of CO_2 gas will be observed.
- Use a delivery tube to pass the CO_2 through limewater.
- The solution will turn cloudy due to formation of $CaCO_3$ precipitate.

NH_4^+ ions

- Add aqueous NaOH and gently warm the mixture.
- The ammonia gas will turn moist pH indicator paper blue.
- Pungent smell given off.

SO_4^{2-} ions

- Add acidified barium chloride solution.
- White ppt forms ($BaSO_4$).

Mixtures of anions

When carrying out the above test, it may be useful to add some HNO_3 before you add $Ba^{2+}_{(aq)}$.The carbonate anion also gives a white precipitate with barium cations, and addition of acid will remove any carbonates present in the mixture. Then, the test for sulfates can be conducted.

Halides

- Add acidified aqueous $AgNO_3$ solution followed by aqueous ammonia solution.
- Cl^- forms a white ppt with silver nitrate which is soluble in dilute NH_3.
- Br^- forms a cream ppt with silver nitrate which is soluble in concentrated NH_3.
- I^- forms yellow ppt with silver nitrate which is insoluble in NH_3.

Testing for various metal cations using sodium hydroxide. Group I hydroxides are all soluble.

Metal cation	add some NaOH	add more NaOH
Mg^{2+}	White suspension	n/a
Ca^{2+}	White suspension, but more soluble than $Mg(OH)_2$	n/a
Sr^{2+}, Ba^{2+}	Soluble hydroxides.	n/a
Zn^{2+}	White ppt, $Zn(OH)_2$. Soluble in NH_3, colourless solution, $Zn(NH_3)_4^{2+}$	Ppt dissolves, colourless solution, $Zn(OH)_4^{2-}$
Al^{3+}	White ppt, $Al(OH)_3$	Ppt dissolves, colourless solution, $Al(OH)_4^-$
Ag^+	Dark brown ppt, Ag_2O. Soluble in NH_3, colourless solution, $Ag(NH_3)_2^+$	Ppt doesn't dissolve
Cu^{2+}	Blue ppt, $Cu(H_2O)_4(OH)_2$, soluble in excess NH_3 to form a deep blue solution, $Cu(NH_3)_4^{2+}$	Ppt doesn't dissolve
Fe^{3+}	Brown ppt, $Fe(OH)_3$	Ppt doesn't dissolve
Fe^{2+}	White/green ppt, slowly turning brown when exposed to air (oxidation to $Fe(OH)_3$)	Ppt doesn't dissolve
Cr^{3+} (green or blue)	Blue-green ppt, $Cr(H_2O)_3(OH)_3$, soluble in NH_3, $Cr(NH_3)_6^{3+}$, violet solution	Ppt dissolves, $Cr(OH)_6^{3-}$ green solution.
Co^{2+}	Blueish ppt, $Co(H_2O)_4(OH)_2$. Slowly turns pink. The precipitate dissolves in NH_3, $Co(NH_3)_6^{2+}$, light brown colour. Turns to dark brown upon standing - slow oxidation to Co(III).	Ppt doesn't dissolve
Ni^{2+}	Green ppt, $Ni(H_2O)_4(OH)_2$. Soluble in NH_3 - blue solution, $Ni(NH_3)_6^{2+}$	Ppt doesn't dissolve
Mn^{2+} (pale pink)	Off-white ppt, $Mn(OH)_2$ turns brown upon exposure to air (oxidation to MnO_2)	Ppt doesn't dissolve

Halides can also be tested for by reacting a solid halide salt with conc. H_2SO_4.

- Chloride produces steamy fumes of HCl.

- Bromide produces steamy fumes, brown vapour (HBr, Br_2, SO_2).
- Iodide produces steamy fumes, purple vapours, black solid (I_2, HI, SO_2 or even solid S).

Transition metal colours

- MnO_4^- = violet
- CrO_4^{2-} = yellow (could be converted to orange $Cr_2O_7^{2-}$ in acid and vice versa).

Test for bromide

- Add chlorine water to a solution of bromides
- Produces an orange solution if present.
- Some effervescence may be observed.

Organic

Haloalkanes

[see CP4, hydrolysis followed by halide test.]

Alkenes

- Add some bromine water to your compound and shake.
- If there are any C=C bonds, the colour change occurs from orange to colourless.

-OH Groups (but not PHENOLS)

- add PCl_5.
- Misty fumes of HCl produced.

- Add a small piece of sodium.
- Effervescence.

Carboxylic acids

- litmus paper turns red-ish.

- Add a carbonate/HCO_3^-
- Effervescence (CO_2)

Aldehydes and Ketones

- Add 2,4-DNP (Brady's reagent).
- An orange precipitate is formed upon reaction with C=O group of aldehyde or ketone.

- Add Tollen's Solution (ammoniacal $AgNO_3$).
- Aldehydes give a positive test and a silver mirror is observed.
- Ketones cannot be oxidised, so no change observed)

- Fehling's test.

- Aldehydes give a positive test and form a brick red precipitate.
- Ketones don't react so the solution stays deep blue).

Iodoform reaction

- Warm with iodine and sodium hydroxide.
- Yellow precipitate.
- Antiseptic smell (triiodomethane, iodoform).
- Positive test with methylketones (e.g. propanone), ethanal, ethanol, and methyl secondary alcohols (e.g. propan-2-ol).

Alcohol (primary, secondary) and Aldehyde

- Warm with acidified (H_2SO_4) and $K_2Cr_2O_7$.
- Colour change from orange to green.

Esterification test

- Gently warm an alcohol and carboxylic acid in presence of conc. H_2SO_4
- Should produce a compound with a characteristic smell, (e.g. pineapples).

Solubility test:

- Compounds with groups that can form H-bonds may be soluble in water, (e.g. amines, alcohols, carboxylic acids etc.)
- Some carboxylic acids may not be soluble in water, but may be soluble in alkaline solution (due to formation of $RCOO^-$).
- Same goes with amines. Some may not be soluble in water, but will be soluble in acidic solution (e.g. formation of RNH_3^+).