

CHEM 9.4.3 ANALYSIS OF IONS

Manufactured products, including food, drugs and household chemicals, are analysed to determine or ensure their chemical composition

3.1 Deduce the ions present in a sample from the results of tests

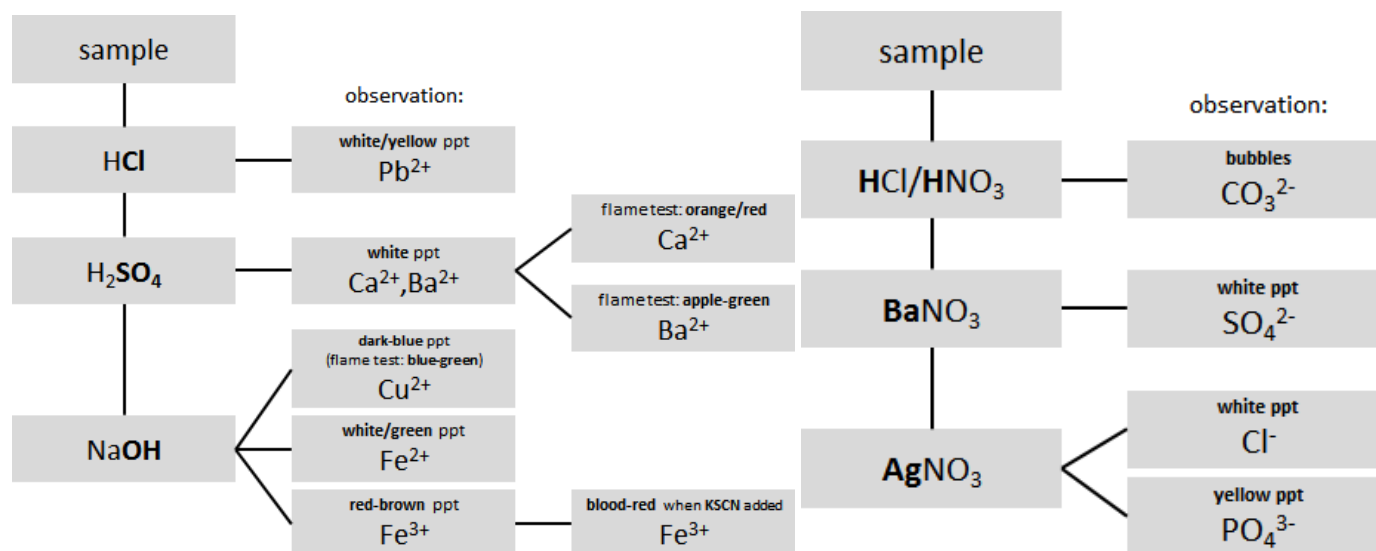
IDENTIFICATION OF CATIONS

Cation	Test	Cation	Test
Pb^{2+}	HCl forms white ppt HI forms yellow ppt	Cu^{2+}	NaOH forms dark-blue ppt Blue-green flame
Ba^{2+}	H_2SO_4 forms white ppt No precipitate NaF Apple green flame	Fe^{2+}	NaOH forms white/green ppt (turns brown) Does not react with KSCN
Ca^{2+}	H_2SO_4 forms white ppt NaF forms white ppt Orange/red flame	Fe^{3+}	NaOH forms red-brown ppt KSCN forms blood-red ppt

IDENTIFICATION OF ANIONS

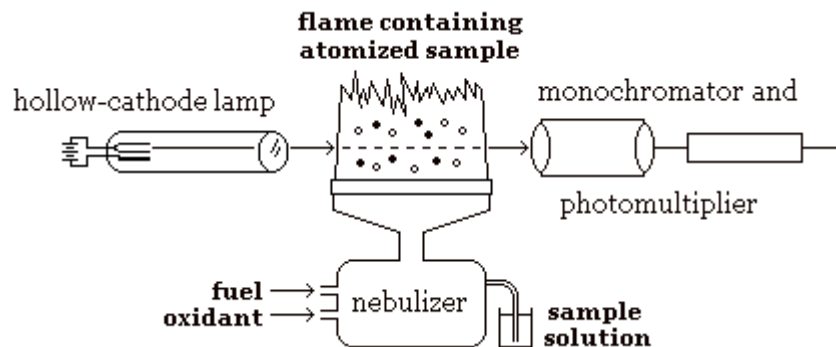
Cation	Test	Cation	Test
CO_3^{2-}	HNO_3 forms bubbles Solution pH 8 to 11	Cl^-	NH_3 , then $Ba(NO_3)_2$ forms white ppt $AgNO_3$ forms white ppt
SO_4^{2-}	$Ba(NO_3)_2$ acidified forms white ppt $Pb(NO_3)_2$ forms white ppt	PO_4^{3-}	$AgNO_3$ acidified forms white ppt

SUMMARY



3.2 Describe the use of **atomic absorption spectroscopy (AAS)** in detecting **concentrations of metal ions** in solutions and assess its **impact on scientific understanding** of the effects of **trace elements**

- AAS used to **quantitatively** find **concentration of metal ions**, developed by Walsh in 1950 CSIRO
 - Very sensitive – 0.01 ppm, can measure **all metal** concentrations
- Solution with metal combusted into flame – **converted to atoms**, which absorb light from lamp where **cathode is metal tested**
- Atoms **absorb light** and determines specific wavelengths which are **absorbed**
 - Gives off an **absorbance** reading
- Absorbance **proportional to concentration** – unknown concentration of element can be found
 - **Calibration curve** used to find precise concentration



USES OF AAS

- Monitor **small concentrations of metals** – esp. heavy metals, and in food
- Measure **concentration of micronutrients** in soils, pollutants in environment
- Concentration of **trace elements**

IMPACT ON UNDERSTANDING THE EFFECTS OF TRACE ELEMENTS

- **Trace elements** – elements **required in living things** in **very small** (1 to 100 ppm) amounts
 - Includes **Zn, Co, Cu, Ni, I**
 - **Human and animal nutrition** – e.g. deficiency in Cobalt in soil in WA – cows were not gaining as much weight from grass
 - **Legumes** (beans) in Victoria – deficiency in Molybdenum

3.P1 Perform first-hand investigations to carry out a **range of tests**, including **flame tests**, to identify the following ions: phosphate, sulphate, carbonate, chloride, barium, calcium, lead, copper and iron

ANION AND CATION TESTS

1. Place one drop of solution onto a spot plate, and place and observe colour changes
 - See solubility rules (attachment) and colours on page 1

FLAME TESTS (CATIONS)

- Blue flame used to prevent interference with colour
1. **Aerosol bottles**
 - Labelled **aerosol bottles sprayed** onto the flame
 - Newspaper laid on table to prevent mess
 2. **Nichrome/Titanium wire**
 - Wire is cleaned by **dipping in concentrated HCl** and placed in flame until glowing red
 - Wire then dipped in **solid powder** of salt, and **held near edge of upper blue** zone of Bunsen Burner
 3. **Paddle Pop Stick**
 - Paddle pop stick left to **soak in substance**
 - Stick placed into flame **at an angle**, and moved **in and out** to prevent stick from burning

Cation	Colour
Barium	pale-green
Calcium	orange-red
Copper	blue-green
Iron	gold

- All tests are **qualitative**

3.P2 Gather, process and present information to describe and explain evidence for the **need to monitor levels** of one of the above **ions** in substances used in society

- Lead **crosses the blood brain barrier**
 - Causes neurological disorders and brain damage
 - Retards **intellectual development in children**
- Previously added in **petrol** (into atmosphere through exhausts) and **paint** (lead-based pigments)
- Monitoring needed **near highways**, in **water** and atmosphere to **reduce exposure**

3.P3 Identify data, plan, select equipment and perform first-hand investigations to measure the **sulfate content of lawn fertiliser** and explain the chemistry involved

- **Gravimetric Analysis**
 1. **0.6 grams** fertiliser **ground** into powder and **weighed**
 2. All powder transferred into beaker, add **25 mL warm** water and 10 drops **HCl**
 3. Heat mixture till boils, add BaCl_2 from burette **until no more white precipitate** forms – required to settle
 4. Reboil until it **coagulates** and let it cool, **filter liquid** from barium sulfate, weigh.

Substance/ Object	Mass (g)
Fertiliser	0.601
Filter paper	1.56
Watch Glass	62.6
Final mass of 2 x filter paper + watch glass+ precipitate	63.02
Precipitate	0.42

- Molar mass of precipitate = $137.3 + 32.07 + 4 \times 16 = 233.37$
 - Since molar mass SO_4 is $32.07 + 4 \times 16 = 96.07$, ratio of sulfate to precipitate is $\frac{96.07}{233.37}$
- Total sulfate content in grams = $\frac{96.07}{233.37} \times 0.42 = 0.1728988 \dots$ grams
- Therefore sulfate content to original fertiliser = $\frac{0.1728988\dots}{0.601} = \mathbf{28.77\%}$

Safety

5 mol **HCl** can burn through clothing and should be used carefully

Hot plate, barium chloride toxic

3.P4 Analyse information to evaluate the **reliability of the results** of the above investigation and to **propose solutions** to problems encountered in the procedure

- Results are **reliable** as:
 - Precise equipment** (electronic scale, measuring cylinder) used
 - Powder **ground** to allow all of it to dissolve
 - Mixture was **left to cool and settle** (solubility decreased at lower temperatures)
 - BaSO_4 was **coagulated** to reduce loss through the filter
- Results are **not reliable** as:
 - Visual identification** to identify completion of **precipitation** reaction
 - BaSO_4 may have **passed through the filter paper** and reduced measured sulfate content
 - Barium sulfate may have been **left on the beaker walls**
- Problems can be solved by:
 - Using **predetermined values** to complete the precipitation reaction
 - Use a **sintered-glass crucible**/filter with smaller pores to prevent BaSO_4 going through
 - Remaining barium sulfate should be **washed off with wash bottle**

3.P5 Gather, process and present information to interpret secondary data from **AAS measurements** and evaluate the **effectiveness** of this **in pollution control**

- AAS used to monitor and manage pollution – **measure levels of pollutants**
- AAS used in **measuring arsenic levels** in drinking water
 - Values placed in a graph to determine **calibration curve**
 - Samples are taken and **absorbance** measured of each sample
 - Concentrations of arsenic then estimated by **plotting on graph**
- Since arsenic levels higher than 100 ppb is considered polluted, much of **Bangladesh's water system** was found to be polluted

