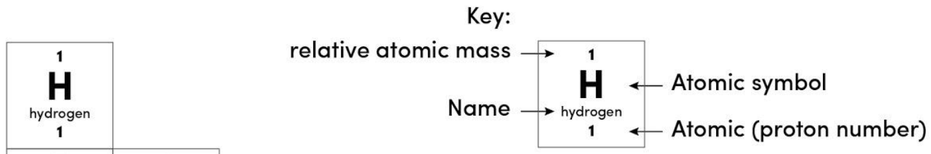
# Ion Identification Problems Worksheet

Separate Science - Chemistry - Key Stage 4

C8 Chemical Analysis

Mr Robbins

# Periodic Table of Elements




| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H hydrogen 1 | | | | | | | | | | | | | | | | 4 He helium 2 |
| 7 Li lithium 3 | 9 Be beryllium 4 | | | | | | | | | | | 11 B boron 5 | 12 C carbon 6 | 14 N nitrogen 7 | 16 O oxygen 8 | 19 F fluorine 9 | 20 Ne neon 10 |
| 23 Na sodium 11 | 24 Mg magnesium 12 | | | | | | | | | | | 27 Al aluminium 13 | 28 Si silicon 14 | 31 P phosphorus 15 | 32 S sulfur 16 | 35.5 Cl chlorine 17 | 40 Ar argon 18 |
| 39 K potassium 19 | 40 Ca calcium 20 | 45 Sc scandium 21 | 48 Ti titanium 22 | 51 V vanadium 23 | 52 Cr chromium 24 | 55 Mn manganese 25 | 56 Fe iron 26 | 59 Co cobalt 27 | 59 Ni nickel 28 | 63.5 Cu copper 29 | 65 Zn zinc 30 | 70 Ga gallium 31 | 73 Ge germanium 32 | 75 As arsenic 33 | 79 Se selenium 34 | 80 Br bromine 35 | 84 Kr krypton 36 |
| 85 Rb rubidium 37 | 88 Sr strontium 38 | 89 Y yttrium 39 | 91 Zr zirconium 40 | 93 Nb niobium 41 | 96 Mo molybdenum 42 | [97] Tc technetium 43 | 101 Ru ruthenium 44 | 103 Rh rhodium 45 | 106 Pd palladium 46 | 108 Ag silver 47 | 112 Cd cadmium 48 | 115 In indium 49 | 119 Sn tin 50 | 122 Sb antimony 51 | 128 Te tellurium 52 | 127 I iodine 53 | 131 Xe xenon 54 |
| 133 Cs caesium 55 | 137 Ba barium 56 | 139 La* lanthanum 57 | 178 Hf hafnium 72 | 181 Ta tantalum 73 | 184 W tungsten 74 | 186 Re rhenium 75 | 190 Os osmium 76 | 192 Ir iridium 77 | 195 Pt platinum 78 | 197 Au gold 79 | 201 Hg mercury 80 | 204 Tl thallium 81 | 207 Pb lead 82 | 209 Bi bismuth 83 | [209] Po polonium 84 | [210] At astatine 85 | [222] Rn radon 86 |
| [223] Fr francium 87 | [226] Ra radium 88 | [227] Ac* actinium 89 | [267] Rf rutherfordium 104 | [270] Db dubnium 105 | [269] Sg seaborgium 106 | [270] Bh bohrium 107 | [270] Hs hassium 108 | [278] Mt meitnerium 109 | [281] Ds darmstadtium 110 | [281] Rg roentgenium 87 | [285] Cn copernicium 112 | [286] Nh nihonium 113 | [289] Fl flerovium 114 | [289] Mc moscovium 115 | [293] Lv livermorium 116 | [293] Ts tennessine 117 | [294] Og organesson 118 |

* The lanthanides (atomic numbers 58 - 71) and the Actinides (atomic numbers 90 - 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

1. A student carried out a series of tests on a group of unknown compounds. The results are summarised in the table below. Identify each compound from the test results and write the balanced chemical formula.

| Compound | Flame test | Addition of sodium hydroxide | Addition of silver nitrate | Addition of acid | Addition of barium chloride |
|---|---|---|---|---|---|
| A | Crimson | No visible change | Yellow precipitate | No visible change | No visible change |
| B | No visible change | Brown precipitate | White precipitate | No visible change | No visible change |
| C | Lilac | No visible change | No visible change | Gas produced. Turned limewater cloudy | No visible change |
| D | No visible change | White precipitate that dissolves in excess | No visible change | No visible change | White precipitate |

2. Give all the positive tests expected from the following compounds

a. $MgCO_3$
b. $CuSO_4$
c. $CaCl_2$
d. $Na_2SO_4$
e. $FeBr_2$
f. $FeI_3$

3. Why do we often add acid before adding our reagent to test for anions?

# Answers

1.

A. Lithium Iodide. LiI
B. Iron(III) chloride. $FeCl_3$
C. Lithium carbonate. $Li_2CO_3$
D. Aluminium Sulfate. $Al_2(SO_4)_3$

2.

a. White precipitate with sodium hydroxide. Gas released on addition of acid which turns limewater cloudy.
b. Green flame test. Blue precipitate with sodium hydroxide. White precipitate with barium chloride.
c. Orange-red flame test. White precipitate with sodium hydroxide. White precipitate with silver nitrate.
d. Yellow flame test. White precipitate with barium chloride.
e. Green precipitate with sodium hydroxide. Cream precipitate with silver nitrate.
f. Brown precipitate with sodium hydroxide. Yellow precipitate with silver nitrate.

3. To remove the carbonate impurity which can ruin the outcome.

# Flame tests

| Ion | Colour of flame |
| --- | --- |
| Potassium | |
| Lithium | |
| Sodium | |
| Calcium | |
| Copper | |

# Cations with sodium hydroxide

| Substance | Ion formula | Colour of precipitate with NaOH |
|---|---|---|
| Copper | $Cu^{2+}$ | |
| Iron (II) | $Fe^{2+}$ | |
| Iron (III) | $Fe^{3+}$ | |
| Aluminium | $Al^{3+}$ | |
| Calcium | $Ca^{2+}$ | |
| Magnesium | $Mg^{2+}$ | |

* Dissolves in excess sodium hydroxide

# Testing for halide ions

| Halide ion | Colour of precipitate |
| --- | --- |
| $Cl^-$ | |
| $Br^-$ | |
| $I^-$ | |

# Example problem

A common fungicide used on grapes is made from two compounds mixed together. Below is the outcome of some tests on one part of the the mixture. Identify the two ions present.

| Test | Result |
| --- | --- |
| Add sodium hydroxide solution | Blue precipitate |
| Add dilute hydrochloric acid and barium chloride solution | White precipitate |

# Partially complete problem

The other compound is expected to be sodium carbonate. Outline two laboratory tests that could be carried out to determine if it was in fact sodium carbonate. Include any observations you would make. [4 marks]

# Independent task

1. A chemist has found a sample of white powder that is unlabelled. To identify they carry out the following tests and record the results in the table below. Name the compound and write its chemical formula.

| Test | Observation |
|---|---|
| Flame test | Orange-red |
| Addition of sodium hydroxide | White precipitate |
| Addition of nitric acid and silver nitrate | Cream precipitate |

# Independent task

2. A student was using a sample of potassium bromide to practice testing for the presence of bromide ions. They followed the following method:

- Place 5 $cm^3$ of sample into a boiling tube
- Add silver nitrate solution dropwise
- Observe the precipitate colour formed

a) What step is missing from the method?
b) What would be the outcome of the test if the potassium bromide was pure?

# Independent task

3. A compound is tested with sodium hydroxide and gives a brown precipitate. A second sample is tested with nitric acid and silver nitrate and gives a yellow precipitate. Name the compound and write the chemical formula.

# Independent task

4. A student has a sample of unknown solid compound. They add water to make a solution and perform the following tests recording their observations.

| Test | Observation |
|---|---|
| Addition of acid | No visible change |
| Addition of sodium hydroxide | White precipitate forms which does not dissolve when excess is added |
| Addition of hydrochloric acid and barium chloride | White precipitate forms |
| Addition of nitric acid and silver nitrate | No visible change |

a) The student believes the sample to be magnesium sulfate. Could their conclusion be correct? Give a reason [3]

b) Their friend thinks it is calcium sulfate. State a laboratory test which would decide who is correct and the observations you would expect. [3]