

Internal Assessment Resource

Chemistry Level 2

This resource supports assessment against Achievement Standard 91911

Standard title: Carry out an investigation into chemical species present in a sample using qualitative analysis

**Credits:** 3

Resource title: Environmental pollution

**Resource reference:** Chemistry 2.2B

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| This resource:   * Clarifies the requirements of the standard * Supports good assessment practice * Should be subjected to the school’s usual assessment quality assurance process * Should be modified to make the context relevant to students in their school environment and ensure that submitted evidence is authentic |

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| Date version published by Ministry of Education | December 2018 Version 1  To support internal assessment from 2019 |
| Authenticity of evidence | Teachers must manage authenticity for any assessment from a public source, because students may have access to the assessment schedule or student exemplar material.  Using this assessment resource without modification may mean that students’ work is not authentic. The teacher may need to change figures, measurements or data sources or set a different context or topic to be investigated or a different text to read or perform. |

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Teacher guidelines

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment using this internal assessment resource.

Teachers need to be very familiar with the outcome being assessed by the achievement standard. The achievement criteria and the explanatory notes contain information, definitions, and requirements that are crucial when interpreting the standard and assessing students against it.

Context/setting

This activity requires students to carry out a comprehensive investigation, using qualitative analysis, of aqueous samples.

Providing an ion identification chart, solubility rules and complex ion formulae guides students to identify the species that are present in the samples.

It is anticipated that this investigation will be introduced at the end of a unit of work that has provided students with knowledge of the preparation of ion identification, identification of species, and the appropriate use of vocabulary, symbols and conventions. Alternatively, students could be provided with relevant information in a resource sheet to enable them to access this activity.

The context for this investigation is environmental pollution. You will need to ensure that students have learned about ion identification and complex ion formation. The identification of types of compound ions are limited to Cl-, CO32-, I-, NO3-, OH-, SO42- , Ag+, Al3+, Ba2+, Cu2+, Fe2+, Fe3+, Mg2+, Pb2+, Na+, Zn2+ and students need to be able to explain the solubility of species.

The activity requires students to present their analysis of water samples and discuss an ion’s effect on humans and /or the environment as a report. The discussion needs to be clearly linked to the purpose of the investigation.

The teacher should include a clear statement providing the context for the investigation, so that students have a purpose for carrying out the qualitative analysis. In this activity water samples from the Waikanakarua river are being investigated for pollutants that have leached into the river, up-stream of the drinking water reservoir, from farming activities.

Conditions

Students might carry out practical tasks individually or may collaborate to share practical tasks amongst a small group. If they work together the teacher would need to use the school’s authenticity procedures to ensure that each student has clear understanding of all criteria involved in the analysis process.

Teachers must ensure their schools risk assessment procedures and practices are followed and are adequate to manage safety aspects of the practical work. Consideration must be given to all chemicals and equipment used, taking into account all possible compounds identified in the resource and the safe disposal of any chemicals used.

Resource requirements

* red/blue litmus paper
* 1 mol L-1 HCl(*aq)*
* 0.1 mol L-1 AgNO3(*aq)*
* 0.1 mol L-1 BaCl2(*aq)*
* 1 mol L-1 NH3(*aq)*
* 1 mol L-1 NaOH(*aq)*
* 0.1 mol L-1 KSCN(*aq)*
* 1 mol L-1 H2SO4(*aq)*
* Unknown solutions:
  + A: 0.1 mol L-1 Na2SO4(*aq*)
  + B: 0.1 mol L-1 Cu(NO3)2(*aq*)
* Safety goggles, test tubes, test tube racks, test tube brushes, droppers.

Students could be provided with information and news articles from the Internet, newspapers, TV, magazines, books, blogs, and advertisements. Students need to be able to explain the significance of the ions found in the solution to the environment and/or people.

Additional information

You should not use the activity exactly as it is (water samples with the same ions in same order) since it is available to all students and the assessment schedule includes examples of appropriate responses.

The teacher could substitute the flow chart given in the student resources for an alternative flow chart/procedure that would enable students to identify the ions in solutions.

Students are not expected to be able to explain the chemistry ideas of complex ion formation.

Teachers need to ensure that protocols are in place to ensure student safety and to meet the requirements of the Hazardous Substances Regulations and the Health and Safety at Work Act.

You should carry out tests prior to the assessment to check that the procedure and sample given to the student can be used to identify the compounds supplied.

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Student instructions

Introduction

You will be assessed on how well you collect primary data using an identification procedure, use this to identify the chemical species and link this to the purpose of the investigation. The report will include a justification of the identification process of the ions identified in the solutions, discuss the significance of the identified chemical species for people and the environment linked to the purpose of the investigation.

The teacher should include a clear statement providing the context for the investigation, so that students have a purpose for carrying out the qualitative analysis. In this activity water samples from the Waikanakarua river are being investigated for pollutants that have leached into the river, up-stream of the drinking water reservoir, from farming activities.

Teacher note: This is an individual task for the practical work but could be modified for students to work in groups of 2-3 (to suit your context and students) to carry out the practical analysis.

Task: Identifying compounds in solutions

Part A: Identify the species in solution

In your groups, use the aqueous solutions and the procedures provided in the resources to identify the species present in each of the following water samples.

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| **Water sample** | **A** | **B** |
| **Ion(s) to identify** | Anion | Cation |

Record the steps you used to identify the ions and any observations you made during the procedures. Use this primary data and the provided secondary data to identify the ion in the water samples.

Method

* Carry out procedures to identify the ion in each water sample using the aqueous solutions and the flow charts provided in Student Resources.
* Record the steps you used to identify the ions and any observations you made during the procedures. Use this primary data to identify the ions in the water samples.

Part B: Reporting on your investigation

Produce a comprehensive and detailed report on your investigation.

The report should include:

* the name or and formula for the ion present in the solutions
* describing the steps you used to identify each ion
* describing the observations you made during each step of the procedure for each ion identified
* identifying by name or formula all precipitates formed
* writing balanced equations for all the reactions where precipitates are formed
* writing balanced equations for all the reactions where complex ions are formed
* linking your observations to any equations you write for the formation of precipitates and/or complex ions
* linking the procedure, observations and the secondary data to justify the identification
* linking the ion identified in the solutions to the purpose of the investigation
* justifying the identification of an ion in terms of the impact on humans and/or the environment.

**Student Resource Booklet**

**Identifying Anions** CO32-, Cl-, I-, SO42-, NO3-, OH-, SCN-

bubbles of gas

*CO32-*

no bubbles

*OH-*

Add dilute HCl solution

litmus goes blue

*OH-, CO32-*

Add red litmus

litmus remains red

*SO42-, Cl-, I-, NO3-*

white precipitate

*SO42-*

Add Ba(NO3)2 solution.

no precipitate

White precipitate disappears

*Cl-*

*new sample*

Add excess dilute NH3 solution.

precipitate

*Cl-, I-*

Add AgNO3

solution

Pale yellow precipitate remains

*I-*

no precipitate

*NO3-*

**Identifying Cations** NH4+, Na+, Mg2+, Ag+, Fe2+, Fe3+, Cu2+, Al3+, Pb2+, Zn2+, Ba2+

add 2 drops, then  
excess NH3 solution

add excess  
NaOH solution

white precipitate forms and disappears, Zn2+

precipitate disappears  
Al3+, Zn2+, Pb2+

precipitate remains  
Mg2+, Ba2+

*New sample*

*New sample*

*To confirm*

*To confirm*

*New sample*

*To confirm*

blue precipitate disappears and blue solution

forms, Cu2+

blue precipitate forms  
Cu2+

brown precipitate forms  
Ag+

brown precipitate forms than disappears solution Ag+

add excess  
NH3 solution

add excess  
NH3 solution

orange precipitate forms  
Fe3+

green precipitate forms  
Fe2+

add dilute H2SO4 solution

colourless solution  
Al3+

white precipitate forms Pb2+

add dilute H2SO4 solution

colourless solution  
Mg2+

white precipitate forms, Ba2+

dark red solution confirms Fe3+

*New sample*

white precipitate forms  
Al3+, Pb2+

add 2 drops KSCN solution

white precipitate forms  
Al3+, Zn2+, Pb2+, Mg2+Ba2+

add 2 drops of dilute NaOH solution.

no precipitate  
NH4+, Na+

add NaOH solution, heat, test gas with red litmus.

litmus stays red Na+

litmus goes blue NH4+

**The Solubility Rules**

* All **Group 1** compounds are soluble
* All **ammonium** compounds are soluble
* All **nitrate** compounds are soluble
* Most **sulfates** aresoluble **except** for calcium sulfate, barium sulfate and lead sulfate
* Most halides are soluble **except** for those salts with silver and lead
* All **carbonates** are insoluble **except** those of Group 1 and ammonium ion
* All **oxides, hydroxides** are insoluble **except** those of Group 1 and ammonium ion
* All **sulfides** are insoluble **except** those of Group 1 and ammonium ion.

**Formulae of Potential Complex ions**

* [Ag(NH3)2]+(*aq*)
* [FeSCN]2+(*aq*)
* [Cu(NH3)4]2+(*aq*)
* [Pb(OH)4]2-(*aq*)
* [Zn(NH3)4]2+(*aq*)

**Assessment schedule: Chemistry 91911 - Environmental pollution**

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| Evidence/Judgements for Achievement | Evidence/Judgements for Achievement with Merit | Evidence/Judgements for Achievement with Excellence |
| The examples of evidence are in response to an activity which asked students to investigate water samples from the Waianakarua river are being tested for pollutants that have leached into the river, up-stream from the drinking water reservoir, from farming activities. | | |
| The student carries out an investigation into chemical species present in a sample using qualitative analysis.  The student has:   * collected primary data using an identification procedure * identified the chemical species present by matching primary data to the procedure * linked the chemical species to the compound present in the sample * described the significance of the identified chemical species for people and/or the environment.   For example:  ***Solution A is SO42-***  *When tested with red litmus paper no colour change is observed.*  *Upon addition of AgNO3 solution,NO change and colourless solution remains.*  *After the addition of BaCl2 solution a white precipitate is produced - barium sulfate (indicates SO42- ion).*  **Solution B is Cu2+**  *When 2 drops of NaOH solution are added, a blue precipitate forms. This is Copper hydroxide/ Cu(OH)2(s).*  *When 2 drops of NH3 is added to a new solution a blue precipitate forms. This is Copper hydroxide/ Cu(OH)2(s) also.*  *When excess NH3(aq) is added the blue precipitate dissolves to form a deep blue solution.*  ***Significance of copper for humans and the environment***  *The Waianakarua river was the drinking water source that has tested positive for the presence of Cu2+ ions. This river flows into the reservoir which supplies drinking water to the local population. The pollutant will therefore flow into the reservoir and the concentration of the pollutant may be high enough to affect the health of the population who drink the water.*  *When in low concentrations copper has little effect on our health but when the concentration increases then people can suffer from hair loss, allergies, arthritis,* [*nausea*](https://www.diagnose-me.com/definition-of/nausea.php)*, vomiting and* [*diarrhoea*](https://www.diagnose-me.com/definition-of/diarrhea.php)*.*  *The examples above are indicative samples only.* | The student carries out an in-depth investigation into chemical species present in a sample using qualitative analysis.  The student has:   * explained the identification of chemical species present by linking the primary data to the procedure * written relevant equations to explain all the changes occurring during the identification procedure * explained the significance of the identified chemical species for people and/or the environment.   For example:  ***Solution A is SO42-***  *When tested with red litmus paper no colour change is observed.*  *Upon addition of AgNO3 solution,NO change and colourless solution remains.*  *After the addition of BaCl2 solution a white precipitate is produced - barium sulfate (indicates SO42- ion)*  *SO42−(aq) + Ba2+(aq) → BaSO4(s)*  **Solution B is Cu2+**  *A blue precipitate formed when 2 drops of aqueous sodium hydroxide was added.*  *Cu2+(aq) + 2 OH−(aq) → Cu(OH)2(s)*  *Addition of a small volume of aqueous NH3 produces a blue precipitate*  *Cu2+(aq) + 2 OH−(aq) → Cu(OH)2(s)*  ***Significance of copper for humans and the environment***  *The Waianakarua river was the drinking water source that has tested positive for the presence of Cu2+ ions. This river flows into the reservoir which supplies drinking water to the local population. The pollutant will therefore flow into the reservoir and the concentration of the pollutant may be high enough to affect the health of the population who drink the water.*  *The copper may have come from copper-based fungicides used by farmers on their pastures.*  *When people have prolonged contact with elevated levels of copper they can exhibit a wide range of symptoms such as hair loss, allergies, arthritis,* [*nausea*](https://www.diagnose-me.com/definition-of/nausea.php)*, vomiting and* [*diarrhoea*](https://www.diagnose-me.com/definition-of/diarrhea.php)*. The copper, which enters their body through the polluted water, enters the blood stream and accumulates in the soft tissues of the liver. The copper disrupts the liver’s metabolic ability to detoxify and cleanse the blood.*  [*http://www.holistic-back-relief.com/copper-toxicity.html*](http://www.holistic-back-relief.com/copper-toxicity.html)  *The examples above are indicative samples only.* | The student carries out a comprehensive investigation into chemical species present in a sample using qualitative analysis.  The student has:   * justified the identification of chemical species present by linking secondary data and chemical principles to the reactions occurring during the analysis * discussed the significance of an identified chemical species for people and/or the environment.   For example:  ***Solution A is SO42-***  *When tested with red litmus paper no colour change is observed.*  *Upon addition of AgNO3 solution,NO change and colourless solution remains.*  *After the addition of BaCl2 solution a white precipitate is produced - barium sulfate (indicates SO42- ion)*  *SO42−(aq) + Ba2+(aq) → BaSO4(s)*  **Solution B is Cu2+**  *A blue precipitate formed when 2 drops of aqueous sodium hydroxide was added*  *Cu2+(aq) + 2 OH−(aq) → Cu(OH)2(s)*  *Addition of a small volume of aqueous NH3 produces a blue precipitate*  *Cu2+(aq) + 2 OH−(aq) → Cu(OH)2(s)*  *Excess aqueous NH3 added, the blue precipitate disappears forming a blue solution*  *Cu(OH)2(s) + 4 NH3(aq) → [Cu(NH3)4]2+(aq) + 2 OH−(aq)*  *We have been using the solubility rules to determine what precipitate forms during the test tube reactions. When the sodium hydroxide is added to the copper compound, a precipitate forms. This would indicate that the compound is a hydroxide that is not in Group 1 or ammonium. Therefore it could be a Group 2, 3 or transition metal. Because the colour of the precipitate is blue, this would give an indication that it is likely to be copper hydroxide. When the precipitate disappeared, and a royal blue solution formed this indicated the presence of a complex ion. The complex ion had copper present.*  *This confirms the presence of Cu2+ ion.*  ***Significance of copper for humans and the environment***  *When the concentrations of copper increase in our drinking water copper may become a pollutant that can affect our health.*  *Copper is essential to the proper functioning of organs and metabolic processes. Copper is an essential trace element that is required in enzyme systems, and enzymes are responsible for countless metabolic processes required to sustain life.*  *The Waianakarua river was the drinking water source that has tested positive for the presence of Cu2+ ions. When Cu2+ ions concentration reaches a critical point then negative effects can be seen on the health of those drinking it, in particular in the functioning of organs and metabolic processes used to sustain life.*  *When the pollutant enters the river up-stream (perhaps from copper-based fungicides used by farmers) it makes its way into the reservoir. The pollutant is then distributed to humans use drinking water from the reservoir. Toxic effects may be seen over time in the population that are consuming the water. Prolonged consumption of Cu2+ with elevated levels can lead to a wide range of symptoms such as hair loss, allergies, arthritis, vomiting and* [*diarrhoea*](https://www.diagnose-me.com/definition-of/diarrhea.php)*. The copper accumulates in soft tissues of the liver and disrupts the liver’s metabolic ability to detoxify and cleanse the blood.*  *.*  [*http://www.holistic-back-relief.com/copper-toxicity.html*](http://www.holistic-back-relief.com/copper-toxicity.html)  [*https://www.amnh.org/learn-teach/young-naturalist-awards/winning-essays2/2014-winning-essays/removal-of-copper-ii-ions-from-contaminated-water-by-encapsulation-of-peppermint-tea-leaves-in-alginate-beads/*](https://www.amnh.org/learn-teach/young-naturalist-awards/winning-essays2/2014-winning-essays/removal-of-copper-ii-ions-from-contaminated-water-by-encapsulation-of-peppermint-tea-leaves-in-alginate-beads/)  [*https://copperalliance.org.uk/knowledge-base/education/education-resources/copper-essential-human-health/*](https://copperalliance.org.uk/knowledge-base/education/education-resources/copper-essential-human-health/)  *The examples above are indicative samples only.* |

Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria in the Achievement Standard.