

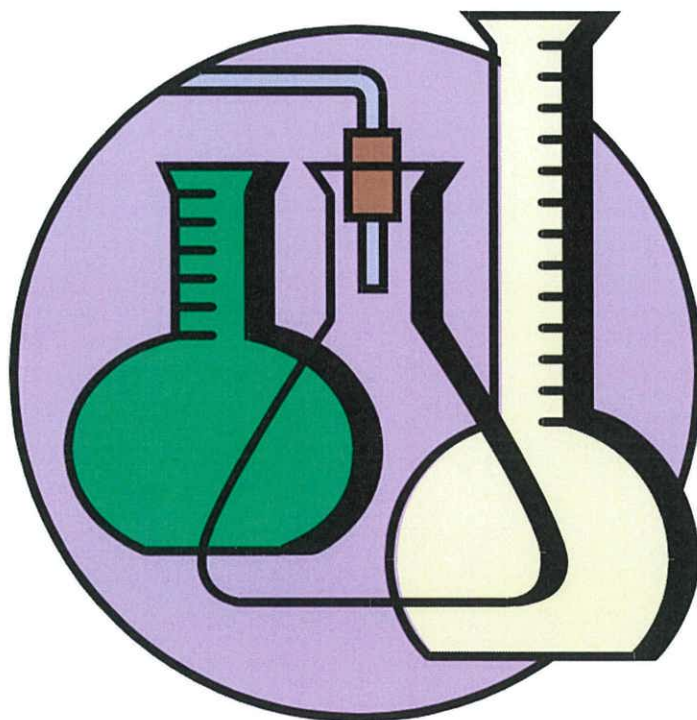


aitken
COLLEGE
In Mind and Spirit

VCE CHEMISTRY

Early Commencement 2018

Practical Book



Contents:

- 1) Growing metallic crystals
- 2) Reactivity of metals in water, acids and oxygen
- 3) Modifying the properties of metals
- 4) Making an alloy

Chapter 3 Metals

Section 3.1 Properties of metals

Experiment 3.1.2 Growing metal crystals

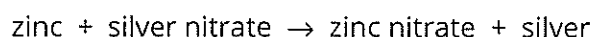
(See Student Workbook for equivalent practical activity)

Purpose

To grow crystals of a range of metals and to observe their shapes.

Theory

Zinc is a more reactive metal than silver, lead, copper or tin. When a piece of zinc is placed in solutions that contain the positive ions of these other metals, the zinc metal reacts to form ions and the ion of the less reactive metal reacts to form its metal. This process can be summarised by the word equation:



Each of the other compounds reacts in a similar way. These reactions are known as displacement reactions.

When a metal is formed quickly, as would be the case if the displacement reaction occurred in aqueous solution, the metal crystals tend to be small. It is difficult to see the details of their shape. If, however, the formation of the metal is slowed down, as when the reaction occurs in agar, larger crystals form and it is easier to examine their shape.

If your crystals have a regular, uniform shape, you can conclude that the particles in the metal are arranged in a regular manner in a crystal lattice.

Duration

15 minutes (if warm agar is prepared before the lesson) plus 10 minutes to observe the crystals on the following 1 or 2 days

Materials

- 0.8 g agar
- 40 mL de-ionised water
- approx. 10 mL 0.1 M solution of one of the following: AgNO_3 , $\text{Pb}(\text{NO}_3)_2$, CuSO_4 , SnCl_2
- 4 cm × 1 cm strip of clean zinc sheet
- 250 mL beaker
- Petri dish
- hotplate or Bunsen burner and bench mat
- tripod
- gauze mat
- glass stirring rod

Safety

- Wear safety glasses, gloves and a laboratory coat.
- AgNO_3 causes burns and stains skin and clothing.
- $\text{Pb}(\text{NO}_3)_2$ is poisonous.
- CuSO_4 irritates the skin and eyes.
- SnCl_2 can irritate the skin and eyes.

Procedure

- 1 Add 0.8 g agar to 50 mL de-ionised water in a beaker.
- 2 Warm gently, stirring until the agar is dissolved. Remove from the heat.
- 3 To the agar solution, add 10 mL of one of AgNO_3 , $\text{Pb}(\text{NO}_3)_2$, CuSO_4 or SnCl_2 . Stir the mixture.
- 4 Pour the agar solution into a Petri dish.
- 5 Place the strip of zinc in the centre of the Petri dish. Do not move the Petri dish until the agar has set.
- 6 Once the agar has set, place a lid on the Petri dish to prevent the agar from drying out.
- 7 Observe the formation of metal crystals over the next 1 or 2 days.
- 8 Repeat the above procedure using each of the metal salts listed.
- 9 Sketch the appearance of the different metal crystals that have been grown in your class.

Title: Growing metallic crystals

Name: _____ Practical Partner(s): _____

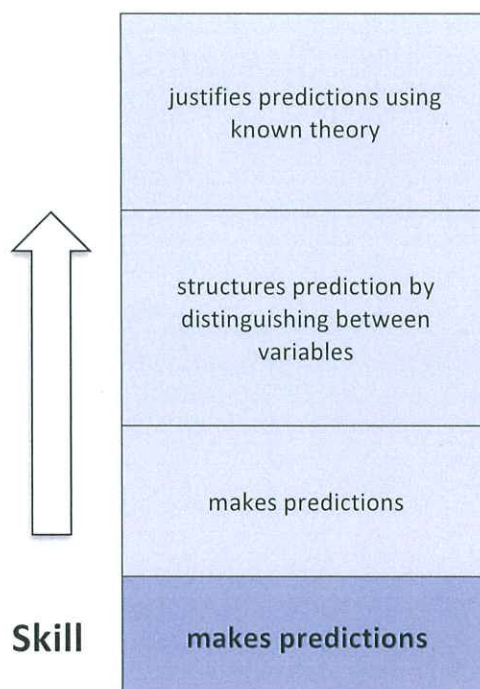
Date experiment performed: _____

Hypothesis

A hypothesis is an **educated** prediction based on scientific ideas of what you think will happen. A good hypothesis will include a scientific reason to justify the reasoning and is usually written as an "If _____ then _____ because _____" statement. It should include the independent and dependent variables, as well as the predicted affect, supported by background theory.

Hypothesis Checklist

	Uses an 'If____ then____ because _____' statement
	Includes the independent variable
	Includes the dependent variable and the predicted effect
	Provides theoretical justification



Chapter 3 Metals

Section 3.3 Reactivity of metals

Experiment 3.3.1 Reactivity of metals with water, acids and oxygen

Purpose

To determine the relative reactivity of a variety of metals with water, acids and oxygen.

Theory

The way metals react with oxygen, water or acid can give us an indication of their relative reactivity. Vigorous reaction indicates a more reactive metal. Transition metals are generally less reactive than Group 1 and 2 metals, but their reactivity varies. A trend across the period or down the group can be explained in terms of the relative attractions of valence electrons to the nucleus of atoms.

When metals react, their atoms tend to form positive ions by donating one or more of their valence electrons to other atoms. Metals with atoms which require less energy to remove electrons tend to be most reactive.

Reaction in air is hard to observe, as most metals do not react quickly with oxygen.

Some metals will react with cold water, and they produce a solution of hydroxide ions, OH^- . The presence of these ions can be observed when the colour changes to pink with the addition of phenolphthalein.

When metals are unreactive in cold water, their behaviour can be observed by increasing the temperature of pure water. If still relatively unreactive, the order of reactivity can be determined by increasing the acidity of the solution with which they react.

Duration

30 minutes

Materials

- small samples of various metals: aluminium, calcium, copper, iron, lead, magnesium, tin, zinc
- larger samples of various metals: aluminium, copper, iron, lead, tin, zinc
- 2 M hydrochloric acid
- phenolphthalein solution
- 8 small test tubes
- wooden test-tube holder
- test-tube rack
- metal tongs
- heatproof mat
- matches
- Bunsen burner
- 2 × pieces of blue glass
- marker pen
- safety glasses

Procedure

Part A—Teacher demonstrations

Sodium: Reaction with water

- 1 Half-fill a pneumatic trough with water and add several drops of phenolphthalein.
- 2 Take the rice-sized piece of sodium and place it on the filter paper so that most of the oil is removed.
- 3 Using tweezers, add the sodium to the pneumatic trough.
- 4 Students should record their observations in the table.

Sodium: Reaction with oxygen

- 1 Take the larger piece of sodium and cut it in half on a board using tweezers and a knife.
- 2 Allow the students to observe the freshly cut surface.
- 3 Students should record their observations.
- 4 Leave the sodium, cut side up, in a Petri dish in a secure place for a short time.
- 5 Allow the students to observe the cut surface again.

Magnesium: Reaction with oxygen

- 1 Take the magnesium ribbon and rub half its length with the scourer.
- 2 Students should observe and record any change in appearance.
- 3 Holding the magnesium with the metal tongs, light it using a Bunsen burner flame.

Safety

- Students and teacher should only look at the burning magnesium through blue glass.
- 4 Students should record their observations.

Part B—Student experiments

Reaction with water

- 1 Using tweezers, place a sample of each metal into labelled test tubes.
- 2 Add water to the test tubes to a depth of 2 cm.
- 3 Add 2 to 3 drops of phenolphthalein solution.
- 4 Record your observations in the table on the next page.
- 5 Gently heat the test tubes until the water is hot (not boiling).
- 6 Record your observations.
- 7 Carefully pour the water out of the test tubes (retaining the metal samples).

Reaction with acid

- 1 Add 2 M hydrochloric acid to a depth of 2 cm **ONLY** to each of the test tubes containing the metals which **did not** react readily with water.
- 2 If there appears to be a reaction, hold a lighted match in the neck of the test tube.
- 3 Record your observations in the table on the next page.

Reaction with oxygen

- 1 Scratch or scrape pieces of aluminium, zinc, lead, tin, iron and copper.
- 2 Record any colour change or dullness in appearance over time.

- 3 Using the Bunsen burner, heat each metal sample. *Ensure that the Bunsen burner is positioned centrally on the heatproof mat.*
- 4 Remove the metal sample from the heat and observe any changes.
- 5 Record your observations in the table.

Metal	Cold water	Hot water	Hydrochloric acid	Oxygen/heat
aluminium				
calcium				
copper				
iron				
lead				
sodium				
magnesium				
tin				
zinc				

Questions

- 1 Write equations for those metals that react with water.
- 2 Write equations for those metals that react with acid.
- 3 Write equations for those metals that react with oxygen.
- 4 Why is the lighted match put in the neck of the test tube when a reaction occurs after acid is added to the metal?
- 5 What could a change in appearance of the magnesium ribbon after rubbing with a scourer suggest?
- 6 List the metals in order of reactivity.

Title: Reactivity of metals with water, acids and oxygen

Name: _____ **Practical Partner(s):** _____

Date experiment performed: _____

Observations

Observations include any changes that occur. Where appropriate you can use photos and labelled diagrams.

Remember to make notes of any unexpected results or aspects of the method that could be improved if the method were modified. These observations will be expanded on in the discussion.

Observations Checklist

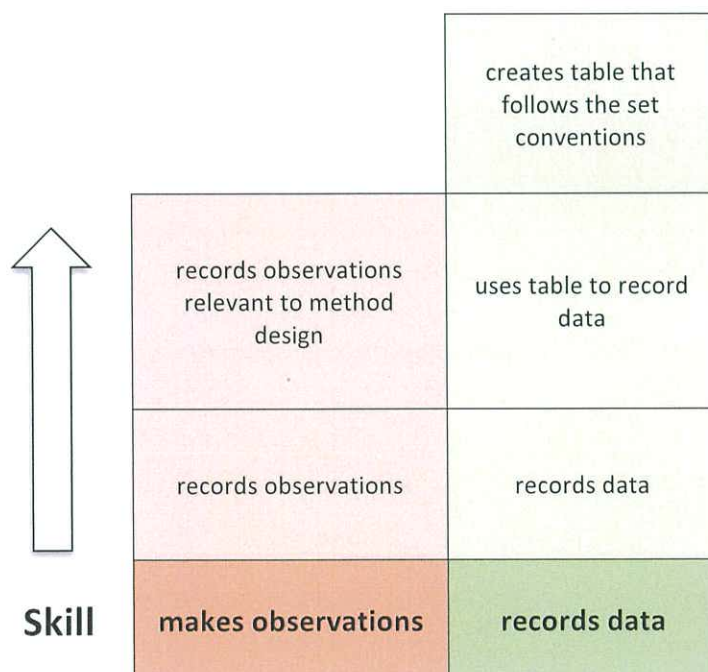
	Includes observed changes
	Includes qualitative information which isn't already included in data table
	Includes information about unexpected results or details of the method

Table of Results

The table(s) must have a title that describes the data, headings for each column and units. The independent variable should be in the far, left column.

Table Checklist

	Includes a detailed title
	The independent variable is in the left column
	Heading given for each column
	Units are included in heading
	Data is given to correct number of decimal places





Modifying the properties of metals

Purpose

To modify the properties of iron by heating.

Procedure

- 1 Set one of the three needles (or hair pins) aside as a control.
- 2 Strongly heat the other two needles, one at a time, in the flame of the Bunsen burner.
- 3 Drop one of the hot needles directly into a beaker of cold water. Allow the other needle to cool very slowly by gradually moving it away from the flame of the burner and allowing it to cool in air.
- 4 When the needles are cool, try to bend them and to break them. Compare this with the control needle. Record your observations.

Theory

The macroscopic properties of a metal depend on its microstructure (the arrangement of its atoms into crystals). When a metal is cooled slowly, the atoms have time to arrange themselves into larger crystals. The metal tends to be more malleable and ductile. If, however, a metal is cooled quickly, the atoms form small crystals only. There are weaknesses where these small crystals join one another, and so the metal tends to be more brittle.

Question

- 1 How does the rate of cooling affect the brittleness and hardness of the metal?

Duration

10 minutes

Materials

- 3 sewing needles or hair pins
- 250 mL beaker
- Bunsen burner
- bench mat
- tongs
- pliers (optional)

Safety

- Wear safety glasses and a laboratory coat.
- Remember not to touch hot metal.

Title: Modifying the properties of metals

Name: _____ **Practical Partner(s):** _____

Date experiment performed: _____

Reporting data

Your discussion of results begins with a report of the data collected. First, summarise the data collected using factual values from the results table. Next, identify trends and patterns that emerge from the data. Sometimes trends and patterns are best observed in a graph of the results. Then, comment on the quality of the data.

Reports data Checklist

	Summarise data in 1 or 2 sentences. Include actual data values
	Identify trends and/or patterns in the data
	Evaluate the quality of data with reference to accuracy, precision, reliability and validity

Analysing results

The second part of your discussion of results is the analysis of results. Trends and patterns often lead to the key finding. The key finding should relate to the aim of the experimental aims and predictions. Use relevant theory to support the key findings in relation to the purpose of the experiment. Depending on the quality of the data, outliers in the data will need to be explained using theory.

Analyses results Checklist

	State the key findings
	Key findings are explained using background theory
	Explain outliers using theory (if applicable)
	Link key findings using theory (if applicable)

 Skill	evaluates quality of data	uses theory to link or reconcile key findings including outliers
	identifies trends and patterns	supports key findings using theories
	summarises data	matches key findings with theory
	includes data	identifies key finding
	reports data	analyses results

MAKING AN ALLOY



Theory

When tin and lead are mixed together when melted, the atoms mix together. Upon cooling, a solid metallic alloy forms called *solder*.

Aim

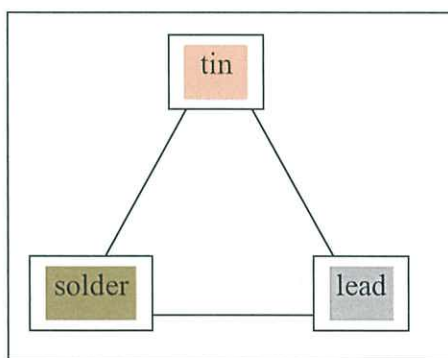
To make a solder and compare its properties to that of tin and lead

Materials

- | | | |
|-----------------|-----------------|-------------------|
| • 2 g lead foil | • Clay triangle | • Tripod |
| • 2 g tin foil | • Spatula | • Iron sheet |
| • Crucible | • Tongs | • Gloves |
| • Bunsen burner | • Metal tray | • 1 cm tin piece |
| • Matches | • Hammer | • 1 cm lead piece |

Method

1. Investigate the properties of lead foil and tin foil. **Record observations.**
2. Prepare 2 g of lead foil and 2 g of tin foil. Roll the two metals together into a ball and place in a crucible.
3. Heat the crucible over a Bunsen burner until the metals melt. Stir with a spatula and remove the oxide layer that forms. Stop heating after 5 to 6 minutes.
4. Remove crucible and use tongs to slowly pour the molten alloy into a metal tray.
5. Flatten the alloy by pressing on it with the head of a hammer or similar object. Allow the alloy to cool further. **Observe and record** appearance and hardness properties of the solder alloy.
6. Place a square sheet of iron on top of a tripod. Arrange 1 cm square pieces of lead, tin and the alloy just made on the sheet of iron so that they form an equilateral triangle. These pieces should be the same size and width.



7. Make sure the squares of lead, tin and solder are flat on the surface of the iron sheet. Heat the iron sheet exactly in the middle of the triangle from below.
8. Note the order in which the three squares melt. **Record results.**

Results & Observations

A. Properties of lead and tin

Observe the properties of lead foil and tin foil.

Metal	Hardness	Appearance	Other properties	Melting pt °C
lead				327
tin				231

B. Properties of the alloy

Describe the appearance and hardness of the solder alloy.

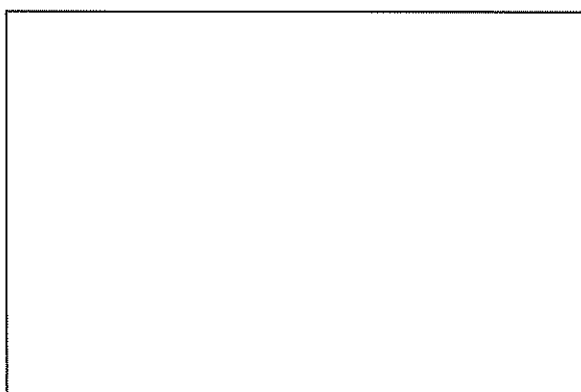
C. Melting point of the alloy

In what order did the three metallic samples melt?

1st _____ 2nd _____ 3rd _____

Is the melting point of the alloy higher or lower than the melting point of the tin and lead?

Draw a diagram to show how the atoms of the lead and tin might be arranged in the alloy. (*Clue: consider the size of respective particles*)



In solder, lead atoms are larger than tin atoms. Would you expect the alloy to be stronger or weaker than either of the pure metals? Explain.

Title: Making an alloy

Name: _____ **Practical Partner(s):** _____

Date experiment performed: _____

Evaluating method

This section includes an evaluation of the experimental method. The checklist below can be used as a guide.

Evaluates method Checklist

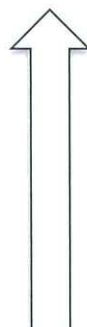
	An explanation of two or more errors is given. These are not mistakes you have made but errors in the method
	Includes an explanation of the modifications that will provide a solution to the errors given above
	An explanation of the safety risks and precautions taken is included

Conclusion

The conclusion briefly summarises and explains the key findings and states where the aims of the experiment were achieved. It is important that no new results information is included in the conclusion. The relevance of the conclusion outside of the laboratory should be stated. Limitations of the conclusion is NOT the same as errors discussed in the method evaluation. Limitations are identified by understanding how the conclusion may or may not be applicable in a wider context, regardless of errors in the method.

Conclusion Checklist

	Includes a statement which summarises the key finding in relation to the aim of the experiment
	Suggests how the findings are applicable in real life
	State limitations of findings and suggest ways to overcome the limitations

 Skill			makes recommendations to overcome limitations
	assesses effect of errors on quality of data	predicts effect of modifications on quality of data	identifies limitations of key findings
	distinguishes between types of errors	explains how modifications improve design	explains implications of key findings
	identifies errors	suggests modifications	summarises key findings
	evaluates method	modifies method	makes conclusions

Practical Skills Rubric: Unit 1 & 2 Chemistry

				evaluates quality of data		uses theory to link or reconcile key findings including outliers				makes recommendations to overcome limitations	
justifies predictions using known theory	uses a risk assessment that follows requirements			creates table that follows the set conventions	identifies trends and patterns	supports key findings using theories	assesses effect of errors on quality of data	predicts effect of modifications on quality of data	identifies limitations of key findings		
structures prediction by distinguishing between variables	controls hazards	records observations relevant to method design	uses table to record data	summarises data	matches key findings with theory	distinguishes between types of errors	explains how modifications improve design	explains implications of key findings			
makes predictions	identifies hazards	records observations	records data	includes data	identifies key finding	identifies errors	suggests modifications	summarises key findings			
makes predictions	assesses risks	makes observations	records data	reports data	analyses results	evaluates method	modifies method	makes conclusions			
Planning		Conduct experiment		Reporting results		Analysing and evaluating results					
Correlation with Chemistry Study Design											
determine hypotheses and predictions that can be tested	apply relevant occupational health and safety guidelines while undertaking practical investigations	systematically generate, collect, record and summarise both qualitative and quantitative data	systematically generate, collect, record and summarise both qualitative and quantitative data	organise, present and interpret data using schematic diagrams and flow charts, balanced chemical equations, tables, graphs, percentages and calculations	take a qualitative approach when identifying and analysing experimental data with reference to accuracy, precision, reliability and validity	Links results to discuss relevant chemical information, ideas, concepts, theories and models and the connections between them			identify the limitations of conclusions	make recommendations, as appropriate, for modifying or extending the investigation	

