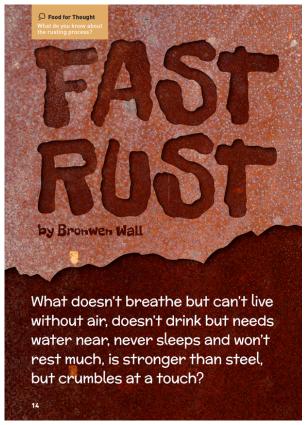
CONNECTED, LEVEL 3 2013, Food for Thought

Fast Rust

by Bronwen Wall



Overview

This article describes the properties of iron and steel and discusses how the metals corrode (rust). It introduces how students can investigate the rusting process themselves.

A Google Slides version of this article is available at www.connected.tki.org.nz.

Science capability

Students need to develop a set of **capabilities** that support them to ask informed questions if they are to participate as "critical, informed, responsible citizens in a society in which science plays a significant role". The capabilities enable students to meet the achievement objectives in a way that supports the purpose of science in *The New Zealand Curriculum* and the development of the key competencies. These capabilities include being ready, willing, and able to **gather and interpret data**. Students need to understand what counts as evidence in science, the importance of observation, and the difference between observation and inference.

Text characteristics

- Abstract ideas accompanied by concrete examples in the text that help support the students' understanding
- Illustrations, photographs, and diagrams that clarify or extend the text and may require some support for students to interpret
- A significant amount of vocabulary that is unfamiliar to the students (including academic and content-specific words and phrases), which is generally explained in the text by words or illustrations.

Curriculum context

SCIENCE

NATURE OF SCIENCE: Investigating in science

Achievement objective(s)

L3: Students will ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.

MATERIAL WORLD: Properties and changes of matter

Achievement objective(s)

L3: Students will group materials in different ways, based on the observations and measurements of the characteristic chemical and physical properties of a range of different materials.

MATERIAL WORLD: Chemistry and society

Achievement objective(s)

L3: Students will relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes.

Key Nature of Science ideas

- Science knowledge is based on direct, or indirect, observations of the natural physical world.
- Scientists gather data, using their senses to make observations.
- Making careful observations often involves measuring something.
- Observations are influenced by what you already know.

Key science ideas

- Corrosion involves a chemical reaction.
- Rusting of iron is an example of corrosion.
- Iron, oxygen, and water must be present for the chemical reaction of rusting to take place.

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ENGLISH

READING

Ideas

L3: Students will show a developing understanding of ideas within, across, and beyond texts.

INDICATORS

- Uses their personal experience and world and literacy knowledge confidently to make meaning from texts.
- Makes meaning of increasingly complex texts by identifying main and subsidiary ideas in them.
- Starts to make connections by thinking about underlying ideas in and between texts.
- Makes and supports inferences from texts with increasing independence.

THE LITERACY LEARNING PROGRESSIONS

The literacy knowledge and skills that students need to draw on by the end of year 6 are described in *The Literacy Learning Progressions.*

Scientific investigation

A science investigation where you change or try something and observe what happens is called an experiment. Not all scientific investigations are experiments; there are many ways of investigating in science. The New Zealand Curriculum science achievement aims indicate that students should experience a range of approaches to scientific investigation including classifying and identifying, pattern seeking, exploring, investigating models, fair testing, making things, and developing systems. Many scientific investigations involve systematic observation over time of an object, an event, a living thing, or a place.

Some important things to remember when you do a scientific investigation are: to be systematic and fair; to make sure that only one thing is changed at a time if you are doing an experiment or fair test so you are sure which changes result in which outcome; to observe and record what happens very carefully; and to be open minded so you notice things you are not expecting.

Sound data is obtained when you are able to get similar outcomes each time you do the same thing, or when data has been collected in the same way and in a systematic manner. No investigation or experiment results in a "wrong" outcome. You may have done something differently from others or the conditions may be slightly different so you don't get the same result as others do, but it is not "wrong".

Thinking about and developing explanations about why things happen the way they do, based on evidence, is an important aspect of science. Another important aspect is critically evaluating methods and ideas. Part of a scientist's work is critiquing and evaluating the methods and ideas of other scientists. They expect their work to be subject to critique. If they are going to be able to make informed decisions about scientific issues as responsible citizens, students first need to experience a range of approaches to scientific investigation and to practise critique and evaluation of scientific methods and ideas – both their own and those of others – just like scientists do!

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Meeting the literacy challenges

The following strategies will support students to understand, respond to, and think critically about the information and ideas in the text. After reading the text, support students to explore the key science ideas outlined in the following pages.

TEXT CHARACTERISTICS

- Abstract ideas accompanied by concrete examples in the text that help support the students' understanding
- Illustrations, photographs, and diagrams that clarify or extend the text and may require some support for students to interpret
- A significant amount of vocabulary that is unfamiliar to the students (including academic and content-specific words and phrases), which is generally explained in the text by words or illustrations.

TEACHER SUPPORT

Want to know more about instructional strategies? Go to:
http://literacyonline.tki.org.nz/Literacy-Online/Teacher-needs/Pedagogy/Reading#Years5-8

http://literacyonline.tki.org.nz/Literacy-Online/Student-needs/National-Standards-Reading-and-Writing

http://www.literacyprogressions.tki.org.nz/

"Working with Comprehension Strategies" (Chapter 5) from *Teaching Reading Comprehension* (Davis, 2007) gives comprehensive guidance for explicit strategy instruction in years 4–8.

Teaching Reading Comprehension Strategies: A Practical Classroom Guide (Cameron, 2009) provides information, resources, and tools for comprehension strategy instruction.

INSTRUCTIONAL STRATEGIES

FINDING INFORMATION IN THE TEXT

Read the riddle out loud to the students and invite them to guess the answer. If they can't guess, tell them that there are more clues in the text. **PROMPT** them to read all of page 15 and try again. **ASK QUESTIONS** to prompt the students to think about the author's purpose and to make connections to their prior knowledge:

- *Why did the author open the article with a riddle?*
- *Why might it be important to know about rust?*
- *What do you know about what causes rust and the effects it can have?*

REVIEW the phrase, "… would munch through a piece of iron as if it were a plate of chips."

- *What language feature does the author use, and why?*
- *In what other ways could the author describe rust?*

ASK QUESTIONS to extend the students' thinking.

- *What is the scientific procedure used to carry out an investigation?*
- *What are some of the important things you need to remember when carrying out scientific investigations?*

USING DIAGRAMS TO CLARIFY THE TEXT

EXPLAIN to the students that they can use the diagram in this text to understand the rusting process.

PROMPT the students to interpret the diagram on page 16 aloud in a shared reading context so that any misconceptions about the visual information can be corrected.

DEALING WITH UNFAMILIAR VOCABULARY

RECORD the new vocabulary from the text on a classroom fact file or word wall. Provide opportunities for the students to incorporate these terms into written language in a range of text types as they discuss and interpret the data they gather.

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Teacher support

Can you guess the answer to the riddle? Here are more clues to help:

- Miro has to oil her bike chain any time it rains to stop the chain from …
- Jake left his skateboard outside for a week, and now the wheel bearings are …
- Tinei's dad is painting the roof to protect it from …

Yes, the answer is rust.

You can find rust eating away at lots of the things we use every day. Given half a chance, rust would munch through a piece of iron as if it were a plate of hot chips! Can you think of places where you have seen rust lately? Make a list, take some photos, and bring some examples to show the class.

Can rust really eat iron?

Iron is probably the most important metal we have on Earth. It is the fourth most common **element** found in the Earth's crust. It makes up about 5 percent of the crust, and it is the sixth most common element found in the universe. However, pure iron is very soft, so to make it more useful, we mix it with other elements, like carbon, to form a hard iron **alloy**, such as steel.

Even though iron alloys such as steel can be extremely strong, they can still rust. "Rust" is the common name we use for the chemical **compound** "hydrated iron oxide". Hydrated iron oxide forms when iron comes in contact with oxygen and water.

Rusting is an example of corrosion.

Students make and record observations in their environment.

Corrosion involves a chemical reaction.

Per Capita is a sculpture by the artist Cathryn Monro. It stands at the corner of Cable and Tory streets in Wellington. It is made of steel. The steel has been allowed to rust to give the **silhouettes** a beautiful, dark red colour.

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The great rust race

Steel rusts faster or slower in different environments. Sometimes, it can take years for a piece of steel to rust. Sometimes, steel will start rusting in a matter of days.

So how important are oxygen and water in making steel rust faster or slower? Why do things made of steel rust faster near the sea?

You can find out what will make the rusting process faster or slower by putting small amounts of steel into different environments and measuring the **rate** that rust develops in each environment.

Try investigating:

1. steel in air with no water present
2. steel in water with no air present
3. steel in water with air present
4. steel in saltwater with air present.

Making careful observations often involves measuring something.

Students carry out a scientific investigation to observe changes in chemical and physical properties.

Scientists ask questions to investigate and to develop possible explanations.

The Auckland Harbour Bridge has been called Auckland's biggest paint job. Three coats of paint stop its 6000 tonnes of steel from rusting. The paint lasts for about four years, though the steel close to the water has to be painted more often than that.

Glossary

alloy – a metal mixed with another element to make the metal stronger or more resistant to corrosion

compound – a combination of two or more elements bonded together

corrode – to be eaten away by a chemical action (such as rusting)

element – in chemistry, the simplest form of a substance, which cannot be broken down by chemicals into anything simpler

rate – how quickly something happens (speed)

silhouettes – outlines

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Exploring the science

Some activities focus directly on the science capability of "gathering and interpreting data" and the Nature of Science strand. Other activities extend student content knowledge. You are encouraged to adapt these activities to make the focus on Nature of Science explicit and to support students to develop the capability to collect and interpret data.

LEARNING FOCUS

Students make observations, gather data, and interpret and discuss outcomes based on their observations.

KEY SCIENCE IDEAS

Key Nature of Science ideas

- Science knowledge is based on direct, or indirect, observations of the natural physical world.
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LEARNING ACTIVITIES

Activity 1: The experiment

Have students follow the investigation as outlined in the article in *Connected*. Encourage the students to think critically.

To find out how important oxygen and water are in making steel rust faster or slower, have students try investigating:

1. steel in air with no water present
2. steel in water with no air present
3. steel in water with air present
4. steel in salt water with air present.

Provide the students with the following instructions so that they can carry out their investigations independently, but under your guidance.

The purpose of this experiment is to find out how important oxygen and water are in making steel rust faster or slower. The method is to put small amounts of steel wool into different environments and measure the rate that rust develops in each environment.

You will need:

- jars (x 4)
- lids (x 4)
- steel wool (x 4 pieces, about the same size – not soap pads and not already rusty)
- cooking oil
- tap or rainwater
- boiled water (boiling removes most of the oxygen dissolved in water and makes it similar to the water found at the bottom of deep lakes)
- salty water (seawater or a solution of boiled water and salt).

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Label the jars A, B, C, and D.

1. Put one piece of steel wool in each jar.
2. Put a lid on jar A (to keep the steel wool dry).
3. In jar B, completely cover the steel wool with boiled water and add a few drops of cooking oil. Put the lid on. (The oil will stop oxygen dissolving back into the water.)
4. In jar C, *just* cover the steel wool with tap or rainwater and put the lid on (to stop evaporation).
5. In jar D, *just* cover the steel wool with salty water and put the lid on.
6. Put the jars in a place that won't be disturbed but where it is easy to observe what happens.
7. Once a day, as close as possible to the same time, check the jars and record what has happened to the steel wool in each environment.
8. Record what you observe happening to the steel wool each school day for four weeks. Record your findings in a table like the following one.

Number of days since start	**Jar A (air but no water)**	**Jar B (boiled water with no air)**	**Jar C (tap or rainwater and air)**	**Jar D (salty water and air)**
(for example) 3	No change	No change	No change	Slight red colouring on the steel wool

As a class, discuss the reasons for the experiment's design, how the students could record their observations, and what they think will happen. Ask:

- *Why do you think you are using different kinds of water in this experiment?*
- *How can we measure the amount of rust?*
- *How can you compare and describe what you see?* [They could make a colour key to compare the level of oxidation in each piece of steel wool, rather like a pH scale with colours and corresponding numbers.]
- *What do you think will happen? Why?*

After the students have completed their investigation, have them think about how to interpret their results. Ask:

- *What are the results telling you? Try putting results in order from fastest to slowest rusting. What does that suggest? Does it answer the experiment's questions?*
- *Were the results what you expected?*
- *Why do things made of steel rust faster or slower?*
- *Why do things made of steel rust faster near the sea?*
- *How do your results compare to others? If you did the experiment again, would you get the same results?*

The students now need to present their results, along with an explanation of the method used and why that method was used, their hypothesis, what they observed, and what they think the data is telling them and why. Before they do so, discuss who they will be presenting their findings to and the form of presentation that would be most appropriate. Some options include a visual presentation, such as time-lapse photographs, a slide share, or a display at a science fair.

One way this could be done is for each group to take on the role of scientists presenting their findings at a conference. This is how scientific ideas become accepted (or are rejected) and critiquing the claims of others is a very important aspect of a scientist's work. It also makes the students aware of possible criticisms as they carry out their investigations. Giving them the opportunity to critique others' methods and claims helps them better understand the process of science.

In assessing the students, look for the following:

- Do students understand the importance of accurate observations?
- Do their reports demonstrate ideas and actions that are appropriate to conducting a "fair test" investigation? (Are their methods systematic and fair?)
- Were the observations they recorded measureable?
- Have they developed a basic understanding of rusting as a chemical change to iron based on the evidence they are presenting?
- Did they use the observations to justify their ideas about rusting?
- Can they relate different environmental conditions to different degrees of rusting using the evidence that they have gathered?
- Are they able to fairly and soundly evaluate and critique claims and methods used by other students?

(Adapted from Building Science Concepts, Book 33 – *Working with Metals*, page 33.)

Activity 2: Design their own experiment

When the students have carried out the experiment in Activity 1, have them design a new experiment to find out what else affects the speed of rusting. Below are some questions that students could use to base their experiment on.

- *Does it matter how much water is in the jar?*
- *What if you did this experiment in a fridge?*

Alternatively, they may have their own questions about the rusting process that they want to investigate.

Activity 3: Is the *Titanic* rusting?

After the students have an idea of how quickly iron rusts in four different environments, ask:

- *How quickly do you think iron shipwrecks, such as the* Titanic, *might rust at the bottom of the sea?*

Have the students do some research to make an estimate. Make sure they have reasons to support their estimates, which they can then discuss to draw a shared conclusion, expressed in a written statement.

Hint: Is there as much dissolved oxygen in deep water as there is in shallow water?

The photos of rusting shipwrecks on the following sites may help the students with their estimates:

http://www.environmentalgraffiti.com/news-incredible-sunken-ships?image=0

http://www.lovethesepics.com/2012/09/48-eerily-intriguing-shipwrecks/

Activity 4: A case file for rust

Have the students collect photos of their own (and from the Internet) of rusting objects in everyday environments. Groups of students could develop a case file for rust. Have them carefully examine the photographs to see the location of each object.

- *Are there common environments where rust seems to occur?*
- *What other features do each example of rusting have in common?*
- *Does rusting occur where two different metals are in contact, for example, copper and steel?*
- *How do these observations fit with the results of your investigations with steel wool?*

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Activity 5: Does rust never sleep?

Have the students carry out investigations into how to inhibit or protect against rust. Have them share their results to make a list of the things we do that help prevent or slow the rusting process.

- *How do these things fit with the evidence you have gathered about the rusting process?*
- *Use the evidence you have gathered about rust to make a list of helpful hints for protecting bikes or skateboards from rust.*

Note that you can find activities for investigating how to prevent corrosion in the following Ministry of Education resources:

- Building Science Concepts, Book 33 – *Working with Metals*.
- *Making Better Sense of the Material World*, Corrosion, pages 88–90.

Extension

The 2009 *New Zealand Herald* article listed in the resources provides a dramatic example of the importance of rust prevention.

Google Slides version of "Fast Rust" www.connected.tki.org.nz

RESOURCE LINKS

Google Slide version of "Fast Rust" www.connected.tki.org.nz

Making Better Sense of the Material World, "Corrosion" (pages 84–90)

Building Science Concepts, Book 32 – *Introducing Metals: The Properties and Uses of Common Metals*

Building Science Concepts, Book 33 – *Working with Metals: The Origins and Applications of Common Metals*

Learnz http://www.learnz.org.nz

New Zealand Herald, "Rust Fears for Bridge" http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10562900

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Number of days since start (date)	Jar A (air but no water)	Jar B (boiled water with no air)	Jar C (tap or rainwater and air)	Jar D (salty water and air)

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