**NZQA**

**Approved**

Achievement standard: 91163 Version 2

Standard title: Demonstrate understanding of the chemistry used in the development of a current technology

Level: 2

Credits: 3

Resource title: A load of fertiliser!

Resource reference: Chemistry VP-2.3 v2

Vocational pathway: Primary Industries

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| Date version published | February 2015 Version 2To support internal assessment from 2015 |
| Quality assurance status | These materials have been quality assured by NZQA. NZQA Approved number A-A-02-2015-91163-02-8144 |
| Authenticity of evidence | Assessors/educators must manage authenticity for any assessment from a public source, because learners may have access to the assessment schedule or exemplar material.Using this assessment resource without modification may mean that learners’ work is not authentic. Assessors/ educators 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. |

Vocational Pathway Assessment Resource

Achievement standard: 91163

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Learner instructions

# Introduction

This assessment activity requires you to demonstrate your understanding of the chemistry used in the development of a fertiliser used in agriculture.

You are going to be assessed on how comprehensively you demonstrate understanding of the chemistry used in the development of a fertiliser used in agriculture.

The following instructions provide you with a way to structure your work so you can demonstrate what you have learnt and achieve success in this standard.

Assessor/educator note: It is expected that the assessor/educator will read the learner instructions, and modify them if necessary to suit their learners.

# Task

The materials we use today are the result of historical developments, planned research, accident, and economic demand. The chemistry of new materials gives them certain properties. The properties of these materials make them useful to society.

You must carry out your work individually. Both your report and your notes will be assessed.

## Process, interpret and report

Select a fertiliser developed in the last twenty years to research, from the following:

* superphosphate
* urea.

Process and interpret secondary information provided by your assessor/educator.

Research the chemistry involved in the development of your selected fertiliser. Find out what experimentation, events and/or discoveries led to the development of this fertiliser.

Prepare your report using your notes only. Show clearly your understanding of the chemistry used in the development of your chosen fertiliser. Hand in your notes with your report.

In your report include:

* historical development of the technology
* appropriate chemistry vocabulary, symbols and conventions (names, formulae and equations, where appropriate)
* description of the chemistry used in the development of your chosen fertiliser
* an explanation of the links between the chemistry and the development of the fertiliser, and how it is useful to farmers
* an evaluation on how the chemistry influenced the development of this fertiliser (this may involve elaborating, applying, justifying, relating, comparing and contrasting, and analysing information)
* evidence for your conclusions, for example historical milestones, quotes from your research.

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Assessor/Educator guidelines

# Introduction

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

As with all assessment resources, education providers will need to follow their own quality control processes. Assessors/educators must manage authenticity for any assessment from a public source, because learners may have access to the assessment schedule or exemplar material. Using this assessment resource without modification may mean that learners' work is not authentic. The assessor/educator may need to change figures, measurements or data sources or set a different context or topic. Assessors/educators need to consider the local context in which learning is taking place and its relevance for learners.

Assessors/educators 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 learners against it.

# Context/setting

This activity requires learners to demonstrate their comprehensive understanding of the chemistry involved in the development of a fertiliser used in agriculture, including the history of its development.

Decide on the format of the final presentation. It could be a poster, a computer presentation, a wiki, or any other suitable format.

# Conditions

This is an individual activity. You will determine the timeframe needed.

Learners may also use their own research findings. Information provided must be sufficient to meet the requirements of the standard.

# Resource requirements

None.

# Additional information

The following websites may be useful:

<http://www.teara.govt.nz/en/superphosphate/2/2>

<http://www.teara.govt.nz/en/superphosphate/3>

<http://www.britannica.com/search?query=superphosphate+manufacture>

<http://www.britannica.com/EBchecked/topic/108720/chemical-industry/82216/The-ammonia-soda-Solvay-process>

<http://www.britannica.com/search?query=urea+manufacture>

<http://www.nutri-tech.com.au/>

<http://www.ballance.co.nz/>

<http://www.dairynz.co.nz/>

# Assessment schedule: Chemistry 91163 – A load of fertiliser!

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| Evidence/Judgements for Achievement | Evidence/Judgements for Achievement with Merit | Evidence/Judgements for Achievement with Excellence |
| The learner demonstrates understanding of the chemistry used in the development of a current fertiliser by:* describing the development of the chosen fertiliser
* giving an overview of the history of the fertiliser‘s development
* using chemistry vocabulary to describe the development and composition of the fertiliser

For example:*Phosphorus, commonly called phosphate, comes from rock phosphate. It is needed for pasture and crop growth on New Zealand soils. It increases the strike rate of seedlings, stimulates root development and flowering, and improves plant growth.**In the early 1800s, there were two important figures in the new science of agricultural chemistry. The first was a French chemist, J. B. Boussingault, who around 1834 began an innovative series of experiments on his farm in Alsace. He created a nutrient balance sheet, comparing the total nutrients applied to a crop with the total taken up by the crop. The second was Justus von Liebig, a German chemist, who patented an original, artificial manure. However, this failed in practice because the manufacturing process made the phosphate unavailable to plants. These two threads of research soon came together, leading to the invention of superphosphate.**Superphosphate is the most commonly used fertiliser in New Zealand to ensure that the soil has sufficiently high phosphorous content. It is manufactured from phosphate rock which is insoluble. To make the fertiliser, phosphate rock is reacted with sulfuric acid.**The reaction between sulfuric acid and phosphate rock is:* *Ca3(PO4)2 + H2SO4 → Ca(H2PO4)2 + CaSO4**Of the large world production of sulfuric acid, almost half goes to the manufacture of superphosphate and related fertilisers.**To make sulfuric acid, sulfur is first burnt to produce sulfur dioxide. S + O2 → SO2.**The sulfur dioxide is then reacted with oxygen in the presence of a V205 catalyst to form sulfur trioxide. SO2 + O2 → SO3.**The sulfur trioxide is absorbed by water to produce sulfuric acid. SO3 + H2O → H2SO4.**The fertiliser is produced in three steps:**Step 1 – phosphate rock blending and grinding. The phosphate rock is ground until at least 75% is less than 75 microns in diameter.* *Step 2 – superphosphate manufacture.**Step 3 – granulation.**The above expected learner responses are indicative only and relate to just part of what is required.* | The learner demonstrates in-depth understanding of the chemistry used in the development of a current fertiliser by:* describing the development of the chosen fertiliser
* giving an overview of the history of the fertiliser‘s development
* using chemistry vocabulary to describe the development and composition of the fertiliser
* making and explaining links between the chemistry and the development of the chosen fertiliser

For example:*In 1843, entrepreneur and agricultural chemist John Bennet Lawes used Boussingault’s methods on his Rothamsted estate near London. Also aware of Liebig’s failure, he made his own phosphate manure using a process he had patented in 1842. This involved treating mineral phosphates with sulfuric acid to make superphosphate. In this form, phosphate is rapidly released into the soil, where it can be used by plants.**Superphosphate is effective in a range of soils and climates, and does not affect the acidity of soil.**Phosphate rock is insoluble, making the phosphorous in the rock unavailable to plants. It is reacted with sulfuric acid to produce a mixture of soluble mono-calcium phosphate and calcium sulphate (approximately 9 % phosphorus) which is able to be used by plants.**One of the basic materials needed to make superphosphate is sulfuric acid. This is produced by burning sulfur and dissolving the fumes in water.**Rock phosphate is then dissolved in the acid. The chemical reaction (which takes about half an hour) produces phosphoric acid and calcium sulfate. These are the main components of superphosphate. The ratio of acid to rock phosphate must be carefully judged: too much sulfuric acid produces excess phosphoric acid.**The steaming product is usually carried on a conveyor belt to storage for maturing. During storage, ‘free’ phosphoric acid continues to react with residual rock phosphate.**Too much liquid can cause the superphosphate to become like putty under mechanical pressure (often referred to as ‘green’ super). This is difficult to use in farm machinery. The problem can be overcome by artificial drying, but this is prohibitively expensive.**The basic chemical reaction in the manufacture of superphosphate is the reaction of insoluble phosphate rock with sulphuric acid to form soluble calcium di-hydrogen phosphate, Ca(H2PO4)2.**PO43- + H2SO4 → H2PO4- + SO42-**The above expected learner responses are indicative only and relate to just part of what is required*. | The learner demonstrates comprehensive understanding of the chemistry used in the development of a current fertiliser by:* describing the development of the chosen fertiliser
* giving an overview of the history of the fertiliser‘s development
* using chemistry vocabulary to describe the development and composition of the fertiliser
* making and explaining links between the chemistry and the development of the chosen fertiliser
* evaluating how the chemistry influenced the development of the fertiliser with respect to its use by farmers

For example the learner includes in their report:*Canterbury Agricultural College was founded at Lincoln in 1878. One of the earliest moves by staff was to import superphosphate. It probably came from Adelaide, Australia, which had the first superphosphate manufacturing plant in the southern hemisphere. From then on, superphosphate set the pace for the development of agriculture in New Zealand.**To maintain a high level of animal and crop production, land in New Zealand usually requires the application of phosphate to supplement that occurring naturally. This is supplied mainly as superphosphate fertiliser.* *Phosphate rock is rich in the mineral Ca3(PO4)2F. The overall equation of the reaction between sulfuric acid and phosphate rock in this form is:**2Ca3(PO4)2F + 7H2SO4 + 3H2O → 3Ca(H2PO4)2H2O + 7CaSO4 + 2HF**The phosphate rock is ground until at least 75% is less than 75 microns in diameter and then analysed for composition. The proportions of the various minerals present are altered to give the desired composition.* *Rock phosphates can range in purity from 62% to 88% tri-calcium phosphate content. This affects the amount of acid needed. The main impurities are silicates, oxides of iron and aluminium, fluoride, and carbonates. These may all complicate the process, or form undesirable emissions.**As with all chemical fertilisers, there are some features of superphosphate that need to be treated with caution (e.g. damaging seeds). Superphosphate and other very soluble fertilisers can damage nearby germinating pasture seeds. To avoid this, each seed can be protected in a lime pellet, or fertiliser should be sown separately.**Fluorosis. Superphosphate contains fluorine, which can cause sickness (fluorosis) in animals that ingest it directly from recently fertilised pasture. The best practice is to ensure that animals do not graze pastures recently top-dressed with superphosphate until rain has washed the foliage clean.**The above expected learner responses are indicative only and relate to just part of what is required* |

Final grades will be decided using professional judgement based on an examination of the evidence provided against the criteria in the Achievement Standard. Judgements should be holistic, rather than based on a checklist approach.