**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: Metal cutting tools

Resource reference: Chemistry VP-2.3 v2

Vocational pathway: Manufacturing and Technology

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| Quality assurance status | These materials have been quality assured by NZQA. NZQA Approved number A-A-02-2013-91163-02-8145 |
| 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

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Learner instructions

# Introduction

This assessment activity requires you to demonstrate your understanding of the chemistry used in the development of steel alloys used by engineers in metal cutting tools.

You are going to be assessed on how comprehensively you demonstrate understanding of the chemistry used in the development of steel alloys used by engineers in metal cutting tools.

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.

Alloys are basically a mixture of two or more metals. Metal cutting tools all contain steel which is a mixture of iron and carbon*.* Steel is much more ductile and malleable than iron alone.More than 90% of all steels are carbon steels.

In this activity you will spend time choosing, examining and comparing the tools, recording and processing the information, and completing a final report.

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

## Part 1: Process and interpret

Select two metal cutting tools made from steel alloys and currently used in industry from the following:

* a cold chisel
* stainless steel knife
* a high speed steel drill bit
* a tungsten carbide tipped saw blade
* an alternative metal cutting tool approved by your assessor/educator.

The tools you select must be made from two different steel alloys.

Research the chemistry involved in the development of the steel alloys used to manufacture your two selected tools.

Find out what motivations, events and/or discoveries led to the development of the steel alloys used to make these tools.

You need to show that you are able to process and interpret information on steel alloys used by engineers in metal cutting tools.

## Part 2: Prepare and present your report

Prepare your report using your notes and the information provided by your assessor/educator. Show clearly your understanding of the chemistry in the development of your chosen steel alloys to make metal cutting tools. 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 steel alloys
* an explanation of the links between the chemistry and the development of steel alloys used in the manufacture of metal cutting tools, and how steel alloys are useful to engineers in manufacturing and technology industries
* an evaluation on how the chemistry influenced the development of the steel alloys used in making metal cutting tools. This may involve elaborating, applying, justifying, relating, comparing and contrasting, and analysing information
* evidence for your conclusions, for example images of related tool development, 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 the steel alloys in two metal cutting tools currently used in the manufacturing and technology industries. They will also include an account of the history of their 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.

# Resource requirements

Learner choice of the metal cutting tool is an important aspect of the task. Learners should be encouraged to find, handle, examine, compare and test the tools of their choice.

# Additional information

The following websites may be useful:

<http://www.teara.govt.nz/en/iron-and-steel/3>

<http://www.nzsteel.co.nz/about-new-zealand-steel>

<http://www.thefabricator.com/article/metalsmaterials/carbon-content-steel-classifications-and-alloy-steels>

# Assessment schedule: Chemistry 91163 – Metal cutting tools

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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 two steel alloys used in current metal cutting tools by:* describing the development of steel alloys used in metal cutting tools
* giving an overview of the history of the steel alloys’ development
* using chemistry vocabulary to describe the development and composition of the alloys, e.g. the chemical equations that describe reactions used to make steel and its alloys

For example:*Ironsand (titanomagnetite) was formed through the breakdown of rocks, originating from volcanic activity in Taranaki, 2.5 million years ago. Experiments to smelt the iron from the ironsand met with little success.**Since 1969, ironsands have been mined at Waikato North Head. The iron-rich, magnetic titanomagnetite sand is concentrated from this by means of gravity and magnetic separation.**This ironsand contains two iron oxide ores: magnetite (Fe3O4) and titanomagnetite (Fe2TiO4). The oxides are reduced with carbon from coal, by the production of carbon monoxide:**C + O2 →CO2**C + CO2 →2CO**Metal cutting tools: the edge of the tool needs to be harder than the material being cut or the blade will become dulled with repeated use. The net result of cutting is two products, the waste or excess material, and the finished part.**These processes can be divided into chip producing and cutting, generally known as machining.**Milling is the shaping of metal or other materials by removing material to form the final shape.**Turning is a metal cutting process for producing a cylindrical surface with a single point tool.**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 two steel alloys used in current metal cutting tools by:* describing the development of steel alloys used in metal cutting tools
* giving an overview of the history of the steel alloys’ development
* using chemistry vocabulary to describe the development and composition of the alloys, e.g. the chemical equations that describe reactions used to make steel and its alloys
* making and explaining links between the chemistry and the development of steel alloys

For example:*It wasn’t until the 1950s, with both the local economy and steel demand growing, that serious consideration was given to utilising ironsand in a home-grown steel industry.* *In New Zealand steel is made by BHP at Glenbrook.**Magnetite is a combination of wusite (FeO) and haematite (Fe2O3). The separate reduction from these two ores are:**FeO + CO →Fe + CO2**Fe2O3 + 3CO →2Fe + 3CO2**Pig iron is poured into a steel-making vessel, along with recycled steel scrap. Oxygen is blown on to the molten mixture to convert the impurities to slag, and fluxes (substances that promote melting) are added to produce liquid steel. The slag is poured off and the molten steel is transferred to a treatment station where it is brought to its final composition.**A tiny amount of carbon (a non-metallic element) makes steel stronger. Stainless steels contain chromium, nickel and other alloying elements that keep the metal bright and rust-resistant.**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 two steel alloys used in current metal cutting tools by:
* describing the development of steel alloys used in metal cutting tools
* giving an overview of the history of the steel alloys’ development
* using chemistry vocabulary to describe the development and composition of the alloys, e.g. the chemical equations that describe reactions used to make steel and its alloys
* making and explaining links between the chemistry and the development of steel alloys
* evaluating how the chemistry influenced the development of steel alloys with respect to their use by engineers in industry, e.g. the needs met by the steel alloys used in metal cutting tools and the new challenges they present

For example:*It wasn’t until the 1950s, with both the local economy and steel demand growing, that serious consideration was given to utilising ironsand in a home-grown steel industry.* *At about the same time, new technologies were evolving overseas that made possible the use of ironsand in steelmaking.**Prior to steel-making at Glenbrook, a slag that is rich in the metal vanadium is separated from the iron. It is a valuable by-product (in the 2000s, 12,000 tonnes per year were exported to China, representing 1% of the world’s vanadium production). Vanadium is used in producing rust-resistant steel, and steel for high-speed tools.**Metals can be heat treated to alter the properties of strength, ductility, toughness, hardness or resistance to corrosion. Common heat treatment processes include annealing, precipitation strengthening, quenching, and tempering. The annealing process softens the metal by allowing recovery of cold work and grain growth. Quenching can be used to harden alloy steels, or in precipitation hardenable alloys, to trap dissolved solute atoms in solution. Tempering will cause the dissolved alloying elements to precipitate, or in the case of quenched steels, improve impact strength and ductile properties.**Often, mechanical and thermal treatments are combined in what is known as thermo-mechanical treatments for better properties and more efficient processing of materials. These processes are common to high alloy special steels, super alloys and titanium alloys.**Bits made from high-carbon steel are more durable than low-carbon steel bits due to the properties conferred by hardening and tempering the material. If they are overheated (e.g. by frictional heating while drilling) they lose their temper, resulting in a soft cutting edge. These bits can be used on wood or metal.**High speed steel (HSS) is a form of tool steel; HSS bits are hard, and much more resistant to heat than high carbon steel. They can be used to drill metal, hardwood, and most other materials at greater cutting speeds than carbon steel bits, and have largely replaced carbon steels.**Cobalt steel alloys are variations on high speed steel which contain more cobalt. They hold their hardness at much higher temperatures, and are used to drill stainless steel and other hard materials. The main disadvantage of cobalt steels is that they are more brittle than standard HSS.**Hi-molybdenum tool steel is heat-treated at 1196 °C and then nitro-carburize finished at 510 °C to be measurably harder than high-speed steel. Nitro-carburized steel withstands substantially higher drilling temperatures while maintaining sharpness.**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.