**NZQA**

**Approved**

Achievement standard: 91061 Version 3

Standard title: Demonstrate understanding of basic concepts related to structures

Level: 1

Credits: 3

Resource title: Stepping up

Resource reference: Construction and Mechanical Technologies VP-1.24 v2

Vocational pathway: Construction and Infrastructure

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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-02-2015-91061-02-7330 |
| 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: 91061

Standard title: Demonstrate understanding of basic concepts related to structures

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Learner instructions

# Introduction

This assessment activity requires you to demonstrate your understanding of basic concepts related to a stepladder structure.

You are going to be assessed on how comprehensively you demonstrate understanding of basic concepts related to a stepladder structure. You need to show that you are able to process and interpret information, and prepare a presentation that discusses how the integrity of the stepladder is established.

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

In this activity you need to show that you are able to process and interpret information, and prepare a presentation that discusses how the integrity of the stepladder is established.

Complete a presentation that demonstrates how safety factors, forces, and structural members and joints contribute towards the integrity of the stepladder (e.g. the use of pin-jointed columns and beams).

In your presentation include the following:

* explain what is meant by tension, compression, torsion, and shear, for example how these forces are generated and applied
* explain how structural members and pin joints transfer forces in a stepladder, for example reaction and frictional force
* identify and describe how these types of structural members resist static point loads, for example how a stepladder absorbs and transfers loads using rungs, stiles and locking devises
* explain the safety factors that relate to static loads acting on structural members of a stepladder, specifically explaining why it is designed for structural capacity beyond the expected load, for example slip-resistant feet and securing a stepladder may increase the stepladder’s capacity
* discuss how the integrity (soundness of construction) of a stepladder would be established by comparing and contrasting the impact of:
	+ the strength, weight, material type, and profile of the structural members of a stepladder
	+ the combination of all the structural members, and the means by which they are joined, for example why specific materials and assembly techniques are used
	+ the safety factors that apply to the stepladder, for example what tests are carried out to calculate specific safety features.

Include any diagrams, 3D models and illustrations to support your explanations.

# Resource A

## Definitions

These definitions are reprinted from the standard (Construction and Mechanical Technologies 91061).

* Structures for this achievement standard are limited to pin-jointed columns and beams. Examples of structures may include (but are not limited to) furniture, ladders, scaffolding, and bridges.
* Forces for this achievement standard are limited to tension, compression, shear and torsion.
* Loads for this achievement standard are limited to static point loads.
* Safety factors for this achievement standard are limited to considerations of the internal loads acting on structural members.
* The integrity of a structure is reliant on (but is not limited to) the strength, weight, material and profile of structural members; the combination and means of joining structural members; and safety factors applied to the structure.

# Resource B

## Useful websites

<http://www.technologystudent.com/forcmom/force1.htm>

<http://www.diydoctor.org.uk/projects/forces.htm>

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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 present evidence of their comprehensive understanding of basic concepts related to the structure of a stepladder, including information about safety factors, forces, types of structural members and joints, and how different design components of the stepladder transfer forces, resist loads, and contribute to its integrity.

# Conditions

Learners could work independently or in groups to develop their understanding, but they need to create their presentation independently, and will be assessed individually.

Decide on the format of the final presentation. It could be presented through a slide show, a portfolio, a display board, or a video, and the material presented could include annotated photographs, flow diagrams, written text, drawings, website links, and functional 3D models.

You may wish to take learners’ preferences into account in deciding on the format.

# Resource requirements

Learners will require access to the internet for research and 3D software.

# Additional information

Designing and making a stepladder is not part of this assessment activity. However, it may be more relevant and motivating for learners to show their understanding if they then use those understandings as part of developing a project.

The understanding expected in this standard is not at the formulaic level: it does not involve calculating units of force.

# Assessment schedule: Construction and Mechanical Technologies 91061 – Stepping up

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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 basic concepts related to the structure of a stepladder by:* describing safety factors as applied to a stepladder

For example:The learner describes how safety factors are used to ensure that structures can hold a weight that exceeds the maximum expected load. A stepladder with a safety factor of 2 would be able to carry twice the expected maximum load before failure occurs.* explaining what is meant by tension, compression, shear and torsion

For example:The learner defines these four terms and explains the impact that these forces have on structural members of a stepladder, using a 3D computer model to enhance the explanations.* identifying the types of structural members and joints used in a stepladder

For example, the learner identifies:* + a pin joint can be a flexible joint between two or more parts of a structure to allow movement; in a stepladder the pin joint connects the front and back stiles at the top
	+ on a 3D model of a stepladder, the ties (stiles and rungs) used on either side share the expected load; a tie is a structural member that has tensile force acting on it when loaded.
* describing how types of structural members resist loads

For example:The learner describes different types of structural members and how they resist static point loads, e.g. the ties (stiles and rungs) of a stepladder resist the tensile force acting on them, and are held together with a pin joint column at the top and a locking mechanism towards the base. This strut (locking mechanism) holds the structural members apart, resisting vertical forces acting on them.*The above expected learner responses are indicative only and relate to just part of what is required.* | The learner demonstrates in-depth understanding of basic concepts related to the structure of a stepladder by:* explaining the safety factors applied to a stepladder

For example, the learner:* + explains different types of internal loads that act on structural members of a stepladder, and how it is designed to carry more than the maximum load it will ever be carrying so that the structure is secure
	+ gives reasons why the structural capacity of a structure needs to be considered beyond actual loads, such as a stepladder with a safety factor of 2 would cover 95% of people using it
	+ includes considerations such as how long a stepladder will be in service for, and what happens if an increased force is applied to it (such as a person carrying a heavy object onto the stepladder).
* explaining how structural members and pin joints transfer forces in a stepladder

For example:The learner explains how the design of a stepladder ensures the internal forces acting on the structural members are always in balance or equilibrium. When this doesn’t occur then the stepladder will fail. Each part of the stepladder (stiles and rungs) and the way they are put together (pin joints, locking mechanism) all need to work together to enable the stepladder to be balanced. For example the front and back of a stepladder act as either ties or struts so that all members in the structure share the load and it remains in balance.* explaining what is meant by tension, compression, shear and torsion

For example:The learner defines these four terms and explains the impact that these forces have on structural members of a stepladder, using a 3D computer model to enhance the explanations.* identifying the types of structural members and joints used in a stepladder

For example, the learner identifies:* + a pin joint can be a flexible joint between two or more parts of a structure to allow movement; in a stepladder the pin joint connects the front and back stiles at the top
	+ on a 3D model of a stepladder, the ties (stiles and rungs) used on either side share the expected load; a tie is a structural member that has tensile force acting on it when loaded.
* describing how types of structural members resist loads

For example:The learner describes different types of structural members and how they resist static point loads, e.g. the ties (stiles and rungs) of a stepladder resist the tensile force acting on them, and are held together with a pin joint column at the top and a locking mechanism towards the base. This strut (locking mechanism) holds the structural members apart, resisting vertical forces acting on them.*The above expected learner responses are indicative only and relate to just part of what is required.* | The learner demonstrates comprehensive understanding of basic concepts related to the structure of a stepladder by:* discussing how the integrity of a structure is established

For example, the learner:* + discusses how the pin joint design of a stepladder contributes to its overall structural integrity; the strut that is used to lock the front and back ties in place also adds to its strength
	+ includes explanations of why material type (aluminium, wood, fibreglass), weight, profile (shape) and assembly techniques of the structural members are chosen for use, and what safety factors are considered in relation to constructing different stepladders
	+ goes on to compare and contrast ways of addressing issues relating to the strength, weight, material type, and profile of the structural members, and how the combination of all the structural members and the means by which they are joined contribute towards the success of different stepladders. Fibreglass stepladders are the most reliable and resilient of the possible materials, as they are light, durable, and the safest to use, however they are the least affordable and may have features not needed by the average homeowner.
* explaining the safety factors applied to a stepladder

For example, the learner:* + explains different types of internal loads that act on structural members of a stepladder, and how it is designed to carry more than the maximum load it will ever be carrying so that the structure is secure
	+ gives reasons why the structural capacity of a structure needs to be considered beyond actual loads, such as a stepladder with a safety factor of 2 would cover 95% of people using it
	+ includes considerations such as how long a stepladder will be in service for, and what happens if an increased force is applied to it (such as a person carrying a heavy object onto the stepladder).
* explaining how structural members and pin joints transfer forces in a stepladder

For example:The learner explains how the design of a stepladder ensures the internal forces acting on the structural members are always in balance or equilibrium. When this doesn’t occur then the stepladder will fail. Each part of the stepladder (stiles and rungs) and the way they are put together (pin joints, locking mechanism) all need to work together to enable the stepladder to be balanced. For example the front and back of a stepladder act as either ties or struts so that all members in the structure share the load and it remains in balance.* explaining what is meant by tension, compression, shear and torsion

For example:The learner defines these four terms and explains the impact that these forces have on structural members of a stepladder, using a 3D computer model to enhance the explanations.* identifying the types of structural members and joints used in a stepladder

For example, the learner identifies:* + a pin joint can be a flexible joint between two or more parts of a structure to allow movement; in a stepladder the pin joint connects the front and back stiles at the top
	+ on a 3D model of a stepladder, the ties (stiles and rungs) used on either side share the expected load; a tie is a structural member that has tensile force acting on it when loaded.
* describing how types of structural members resist loads

For example:The learner describes different types of structural members and how they resist static point loads, e.g. the ties (stiles and rungs) of a stepladder resist the tensile force acting on them, and are held together with a pin joint column at the top and a locking mechanism towards the base. This strut (locking mechanism) holds the structural members apart, resisting vertical forces acting on them.*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.