**NZQA**

**Approved**

Achievement standard: 90936 Version 3

Standard title: Demonstrate understanding of the physics of an application

Level: 1

Credits: 2

Resource title: Tower cranes

Resource reference: Physics VP-1.2 v2

Vocational pathway: Construction and Infrastructure

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| Quality assurance status | These materials have been quality assured by NZQA. NZQA Approved number A-A-02-2015-90936-02-7284 |
| 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 how physics is used to allow tower cranes to lift objects and materials on a building site.

You are going to be assessed on how you demonstrate comprehensive understanding of the physics of an application. You need to show that you can process and interpret information, and prepare a report that includes the key physics used by tower cranes and a detailed and comprehensive explanation of how the physics that has been identified is integrated within the application.

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

You are employed by a large construction company and you are learning to operate tower cranes. Your supervisor has asked you to demonstrate your knowledge and understanding of how to operate tower cranes safely as part of your training.

The tower cranes owned by the company have the ability to raise materials and objects to great heights. Understanding the physics of how objects move, and how to keep the crane balanced and stable is vital to ensuring a safe construction site.

There are two sections to your task. The first section requires you to construct a model of a tower crane using drinking straws, tape and string to investigate how to construct a stable crane and to demonstrate how your model crane can remain balanced and move loads.

For the second section you will research the physics of tower cranes in terms of specifications of heights, loads, balancing forces and levers. You will focus on one of these cranes in particular and how it operates. Choose the size of the crane you wish to report on as part of the information.

Report on your understandings by doing the following:

* Carry out research into types of tower cranes and how they operate. See Resources for useful websites. Use your knowledge of physics to produce a report that explains how or why cranes remain balanced and stable, and how this makes it possible for tower cranes to raise loads to great heights and move them into position.
* Construct a model of a tower crane using drinking straws, tape and string, to demonstrate your understanding of how these cranes are designed and how they operate. Investigate how different loads and distances from the axis of the crane affect movement and stability.
* Make sure your report clearly demonstrates your understanding of the way physics is used in the construction and operation of a tower crane, by investigating such things as:
	+ the force of the load and the force of the balancing mass
	+ how the size and position of the balancing mass must be changed depending on the size and position of the load
	+ how tower crane structures are designed and secured at the base to optimise strength and stability
	+ energy changes as a load is raised to a great height
	+ changes in kinetic energy and speed if an object falls from a crane at a great height
	+ drawing graphs of force and speed for an object that falls and lands from a great height
	+ how hard hats in a construction area reduce the risk of serious injury in terms of forces, area, pressure and impact time
	+ analysing the motion of an object that is raised and moved sideways in terms of forces, motion and increased risk factors.

You may use measurements and calculations as part of your report.

* Produce your report, which could be:
	+ a written report, including illustrations, calculations, diagrams, and graphs, if appropriate
	+ a poster, including annotations or supporting notes
	+ an oral presentation, with written references
	+ a project booklet
	+ a multi-media report, for example, a recorded video report or web page with embedded video, graphics, and text
	+ a computer presentation software file.
* Use your own words, unless quoting, and clearly indicate any direct quotes. Your report should be between two and four A4 pages in length, including any illustrations, diagrams, and graphs. If the work is in another format, it should be of equivalent length. All sources of information, images, diagrams, and data must be acknowledged and referenced in a format that enables them to be easily traced.
* Non-text formats, for example an oral report, must be supplemented by a written list of references.

# Resources

Useful websites include:

<http://www.physicsclassroom.com/class/newtlaws/u2l1d.cfm>

<http://www.physics4kids.com/files/motion_force.html>

<http://science.howstuffworks.com/transport/engines-equipment/tower-crane.htm>

<http://cranephysics.weebly.com/>

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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 comprehensive understanding of the physics used by tower cranes to raise loads to great heights and move them into position. The learner must prepare a report identifying the key physics used by tower cranes, giving a detailed and comprehensive explanation of how the physics that has been identified is integrated within the application.

# Conditions

Learners need to create their report independently, and will be assessed individually.

You will need to decide on the format of the final report. 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.

# Additional information

None.

# Assessment schedule: Physics 90936 – Tower cranes

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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 physics used by tower cranes to raise loads to great heights and move them into position by:* identifying the key physics involved with a tower crane
* describing how the physics that has been identified is used

For example, the learner:* + describes how each arm of the tower crane acts as a lever
	+ draws a labelled diagram to show the relative sizes of the individual forces acting
	+ describes the difference between mass and weight
	+ constructs a simple working model tower crane to demonstrate design features that help to make a crane strong and stable
	+ demonstrates the size and position required for a balancing mass to counter a given load
	+ calculates weight for a given load
	+ describes energy changes as an object is lifted to a great height.

*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 physics used by tower cranes to raise loads to great heights and move them into position by:* identifying the key physics involved with a tower crane
* explaining how or why the physics that has been identified is used

For example, the learner:* + calculates the mass and position required to balance a given load and position
	+ explains the importance of balance in terms of forces and levers
	+ calculates the change in kinetic energy and speed if an object is dropped from a great height
	+ explains the physics of important features designed to keep the whole crane structure stable, such as contact points and secure attachments at the base.

*The above expected learner responses are indicative only and relate to just part of what is required.* | The learner demonstrates comprehensive understanding of the physics used by tower cranes to raise loads to great heights and move them into position by:* identifying the key physics involved with a tower crane
* giving a detailed and comprehensive explanation of how the physics that has been identified is integrated within the application. A comprehensive explanation may involve elaborating, justifying, relating, evaluating, comparing and contrasting, or analysing

For example, the learner:* + evaluates the maximum operating limits for a particular tower crane in terms of forces and safety
	+ compares the operating specifications of two different cranes
	+ analyses the motion of an object on a model tower crane as it is raised and moved sideways
	+ elaborates on how the motion of an object suspended from a crane may cause greater safety concerns due to changes in tension forces and possible pendulum action
	+ draws graphs of force and speed versus time for an object that falls and lands from a great height
	+ explains how hard hats in a construction area reduce the risk of serious injury.

*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.