**NZQA**

**Approved**

Achievement standard: 91257 Version 2

Standard title: Apply graphical methods in solving problems

Level: 2

Credits: 4

Resource title: Monitoring motors

Resource reference: Mathematics and Statistics VP-2.2 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-02-2015-91257-02-8190 |
| 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 apply graphical methods in solving problems related to power output ranges for engines.

You are going to be assessed on how you apply graphical methods, using extended abstract thinking, in solving problems, by devising a strategy and developing a chain of logical reasoning to determine power output for different carburettor settings.

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.

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| --- | --- |
| **Time (secs)** | **Power (revs/min)** |
| 10 | 210 |
| 20 | 370 |
| 30 | 590 |
| 40 | 880 |
| 50 | 1540 |
| 60 | 3100 |
| 70 | 4810 |
| 80 | 5400 |
| 90 | 6000 |

# Task

An engineering company is testing the motors it makes. A test motor is started and run for a particular carburettor setting. The power output of the motor (in revs per minute) is measured at different times until it reaches its maximum output of 6000 revs/min after 90 seconds.

The results are shown opposite:

The company wants to use a graphical model to establish the power output range for low (the first 30 seconds), medium (from 30 seconds to 60 seconds) and high (from 60 seconds to 90 seconds) power outputs. The motor runs for equal time intervals for each of these output classifications.

You need to do the following:

* Investigate possible graphical models for the power output, using data values from 0 to 90 seconds. Find the equation for each model. You should investigate the following models; power, log, exponential, parabolic, and cubic.
* Decide which of the investigated models best fits the data. You need to justify your choice by discussing how well the model fits the data, and also identifying features of the models (for example their basic shape, intercepts, symmetry, turning points, large value behaviour).
* You might want to improve your best model by using a piecewise function.
* Use your best model to estimate the power output range for each of the power output classifications.

The manufacturer also tests the motor for different carburettor settings. For the second setting, the power increases in a similar way to the first setting, but reaches the maximum output of 6000 revs/min after 80 seconds rather than 90 seconds. It is then run for another 10 seconds at this maximum rate.

Adapt the function(s) from your first model so that it models the power output for the new carburettor setting, for running times from 0 to 90 seconds.

The manufacturer slows down the motor on this new setting until it stops. The motor slows down in such a way that the power output graph is symmetrical about the line t=90.

Sketch the graph of your new model and write down its equation, which describes the power output from when it starts until it stops.

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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 use extended abstract thinking when applying graphical methods in solving problems. They are required to investigate different non-linear models for a set of data. The data comes from the results of running a motor over a period of time.

# Conditions

Learners need to work independently to complete this activity.

# Resource requirements

Assessors/educators are expected to replace the data provided with information specific to their own situation. The data set must allow a meaningful investigation of different graphical models.

Learners should have access to appropriate technology.

# Additional information

Ensure learners are familiar with any context specific vocabulary used in this resource.

# Assessment schedule: Mathematics and Statistics 91257 – Monitoring motors

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| Evidence/Judgements for Achievement | Evidence/Judgements for Achievement with Merit | Evidence/Judgements for Achievement with Excellence |
| The learner applies graphical methods in solving problems by:   * selecting and using graphical methods * demonstrating knowledge of the properties of functions and graphs * communicating using appropriate representations   For example, the learner has:   * + connected the data with the graph of a model and its equation for more than one model   + discussed the appropriateness of the models with respect to identified features of the functions   + used a model to estimate power output ranges for each of the classifications.   *The examples above are indicative of the evidence that is required.* | The learner applies graphical methods, using relational thinking, in solving problems by involving one or more of:   * selecting and carrying out a logical sequence of steps * connecting different concepts or representations * demonstrating understanding of concepts * forming and using a model   and also relating findings to a context, or communicating thinking using appropriate mathematical statements  For example, the learner has:   * + connected the data with the graph of a model and its equation for more than one model   + discussed the appropriateness of the models with respect to identified features of the function, and related these to the context, then decided, with reasons, on a best model and used it to estimate power output ranges for each of the three classifications   + established a model for the second carburettor setting, and extended the model for times up to 180 seconds by using either a graph or equation.   *The examples above are indicative of the evidence that is required.* | The learner applies graphical methods, using extended abstract thinking, in solving problems by involving one or more of:   * devising a strategy to investigate a situation * identifying relevant concepts in context * developing a chain of logical reasoning, or proof * forming a generalisation   and also using correct mathematical statements, or communicating mathematical insight  For example, the learner has:   * + decided, with reasons, on a best model, and used it to estimate power output ranges for each of the three classifications   + established a model for the second carburettor setting, and demonstrated an understanding of the given symmetry by extending the model for times up to 180 seconds, using both a graph and equation.   *The examples above are indicative of the evidence that 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.