Mathematics Stage 5 – unit of learning

Maths in science elective

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# Rationale

The NSW Department of Education publishes a range of curriculum support materials, including samples of lesson sequences, scope and sequences, assessment tasks, examinations, student and teacher resource booklets, and curriculum planning and curriculum evaluation templates. The samples are not exhaustive and do not represent the only way to complete or engage in each of these processes. Curriculum design and implementation is a dynamic and contextually-specific process. While the mandatory components of syllabus implementation must be met by all schools, it is important that the approach taken by teachers is reflective of their needs and faculty/school processes.

The NSW Education Standards Authority (NESA) defines [programming](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming) as ‘the process of selecting and sequencing learning experiences which enable students to engage with syllabus outcomes and develop subject specific skills and knowledge’ (NESA 2022). A program is developed collaboratively within a faculty. It differs from a unit in important ways, as outlined by NESA on their [Advice on units page](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming/advice-on-units). A unit is a contextually-specific plan for the intended teaching and learning for a particular class for a particular period. The organisation of the content in a unit is flexible and it may vary according to the school, the teacher, the class, and the learning space. They should be working documents that reflect the thoughtful planning and reflection that takes place during the teaching and learning cycle. There are mandatory components of programming and unit development, and this template provides one option for the delivery of these requirements. The NESA and department guidelines that have influenced this template are elaborated upon at the end of the document.

This resource has been developed to assist teachers in NSW Department of Education schools to create learning that is contextualised to their classroom. It can be used as a basis for the teacher’s own program, assessment, or scope and sequence, or be used as an example of how the new curriculum could be implemented. The resource has suggested timeframes that may need to be adjusted by the teacher to meet the needs of their students.

# Overview

**Description:** this program of learning addresses content from the Path focus areas of Variation and rates of change A, Variation and rates of change B, Non-linear relationships C, and Logarithms. The lessons and sequences in this program of learning are designed to allow students to explore applications of mathematics in science. Students will explore rates of change, non-linear relationships, and logarithms in real world contexts.

This unit is designed to be an elective unit to extend students that have completed the Core content within Stage 5. All lessons incorporate Path content and assume students are confident with related Core content.

**Duration:** this program of learning is designed to be completed over a period of approximately 5 weeks, but can be adapted to suit the school context.

**Explicit teaching:** suggested learning intentions and success criteria are available for some lessons provided. Learning intentions and success criteria are most effective when they are contextualised to meet the needs of students in the class. The examples provided in this document are generalised to demonstrate how learning intentions and success criteria could be created.

# Outcomes

## Core

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly
**MAO-WM-01**

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## Path

A student:

* identifies and solves problems involving direct and inverse variation and their graphical representations **MA5-RAT-P-01**
* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MA5-RAT-P-02**
* interprets and compares non-linear relationships and their transformations, both algebraically and graphically **MA5-NLI-P-01**
* establishes and applies the laws of logarithms to solve problems **MA5-LOG-P-01**

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**Prior to planning for teaching and learning, please consider the following:**

**Engagement**

* How will I provide authentic, relevant learning opportunities for students to personally connect with lesson content?
* How will I support every student to grow in independence, confidence, and self-regulation?
* How will I facilitate every student to have high expectations for themselves?
* How will I identify and provide the support each student needs to sustain their learning efforts?

**Representation**

* What are some different ways I can present content to enable every student to access and understand it?
* How will I identify and address language and/or cultural considerations that may limit access to content for students?
* How will I make lesson content and learning materials more accessible?
* How will I plan learning experiences that are relevant and challenging for the full range of students in the classroom?

**Expression**

* How will I provide multiple ways for students to respond and express what they know?
* What tools and resources can students use to demonstrate their understanding?
* How will I know every student has understood the concepts and language presented in each lesson?
* How will I monitor if every student has achieved the learning outcomes and learning growth?

# Lesson sequence and details

## Learning episode 1 – graphing stories

### Teaching and learning activity

Students represent rates of change using graphs, with an emphasis on linear graphs and gradient.

### Syllabus content

* Recognise and describe direct variation from graphs, noting that the graph of is a straight line passing through the origin, with its gradient being the constant of variation
* Represent a given description of a variable rate of change of one quantity over time

Table 1 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Graphing stories (DOCX 1016 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l01-graphing-stories.docx)Duration: 1 lessonLearning intention* To be able to represent a rate of change of one quantity over time.

Success criteria* I can graph the change in a quantity over time.
* I can describe the rate of change in linear graphs.
* I can explain the connection between rate of change and gradient.
 | * One digital device per pair
* [*Graphing stories* (PPTX 606 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l01-graphing-stories.pptx) PowerPoint
* Sets of Appendices A and B, printed A3 (1 per group of 3)
* Sets of Appendices C and D printed, cut into cards (1 per group of 3)
* A3 plastic pockets (1 per group of 3)
* Adhesive putty
* Whiteboard markers (1 per group of 3)
 |  |

## Learning episode 2 – graph-ity falls

### Teaching and learning activity

This learning episode introduces students to distance-time graphs which are an important lead into motion graphs in physics. Students will match graphs to stories and describe the rate of change of distance-time graphs.

### Syllabus content

* Interpret distance–time graphs when the speed is variable, describing the rate of increase or decrease, the initial and final points, constant relationships represented by straight lines and variable relationships represented by curved lines
* Describe the rate of change between variables in a variety of contexts including direct and inverse variation
* Describe qualitatively the rate of change of a graph, using terms such as increasing at a decreasing rate

Table 2 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Graph-ity falls (DOCX 364 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l02-graph-ity-falls.docx)Duration: 1–2 lessonsLearning intention* To be able to analyse and construct graphs related to rates of change.

Success criteria* I can match a distance-time graph to its description.
* I can draw a distance-time graph to match a given scenario.
 | * One digital device per pair
* A3 plastic pockets (1 per group of 3)
* Appendix A, printed A3 (1 per group of 3)
* Adhesive putty
* Whiteboard markers (1 per group of 3)
* [*Graph-ity falls* (PPTX 1.2 MB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l02-graph-ity-falls.pptx) PowerPoint
* Ball for teacher to throw
 |  |

## Learning episode 3 – direct variation

### Teaching and learning activity

Students explore applications of direct variation such as electrical circuits and Charles’s Law to understand direct variation’s relevance in science. Students are explicitly taught how to construct equations and solve problems involving direct variation.

### Syllabus content

* Describe typical examples of direct variation/proportion
* Apply the language of direct variation to everyday contexts: is directly proportional to , is proportional to , varies directly as
* Identify and represent direct variation/proportion as ∝ ( is proportional to ) or , where is the constant of variation
* Solve problems involving direct or inverse variation using an equation
* Graph equations representing direct variation, with or without digital tools

Table 3 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Direct variation (DOCX 1370 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l03-direct-variation.docx)Duration: 1–2 lessonsLearning intention* To understand what makes 2 variables directly proportional.

Success criteria* I can construct an equation for two variables that are directly proportional.
* I can graph equations representing direct variation.
* I can explain why a problem does or doesn’t represent direct variation.
 | * One digital device per pair
* Appendices
* [*Direct variation* (PPTX 1.1 MB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l03-direct-variation.pptx) PowerPoint
* Class set of Appendices A, B, C and D, printed

**Optional*** A heat resistant beaker or glass (1 per group of 3)
* Pre-frozen balloon blown up and left in a freezer for 2–3 hours (1 per group of 3)
* Room temperature balloon (1 per group of 3)
* Boiling water
* A 30 cm ruler (1 per group of 3)
* Personal Protective Equipment
 |  |

## Learning episode 4 – inverse variation

### Teaching and learning activity

Students explore inverse variation through an experiment; collecting and graphing data to describe the shape and characteristics of inverse variation. Students are explicitly taught how to construct equations and solve problems involving inverse variation.

### Syllabus content

* Describe typical examples of inverse (indirect) variation
* Apply the language of inverse variation to everyday contexts: is inversely proportional to , is proportional to the reciprocal of , varies inversely as
* Identify and represent inverse variation/proportion as ∝ ( is inversely proportional to ) or , where is the constant of variation
* Recognise and describe inverse variation from graphs, noting that the graph of is a curve

Table 4 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Inverse variation (DOCX 1392 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l04-inverse-variation.docx)Duration: 1–2 lessonsLearning intention* To understand what makes 2 variables inversely proportional.

Success criteria* I can identify problems that involve inverse variation.
* I can construct an equation for 2 variables that are inversely proportional.
* I can explain why a problem does or does not represent inverse variation.
 | * One digital device per group of 3
* Balloon (1 per group of 3)
* Stopwatch (1 per group of 3)
* Measuring tape (1 per group of 3)
* Torch or lamp (1 per group of 3)
* Objects to measure
* Card or paper
* Scissors (1 per group of 3)
* Ruler (1 per group of 3)
* [*Inverse variation* (PPTX 1.1 MB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l04-inverse-variation.pptx) PowerPoint
* Class set of Appendices A, B, C and D, printed
 |  |

## Learning episode 5 – para-solar

### Teaching and learning activity

Students explore the relationship between the equation of a parabola and its focus through an experiment with parabolic solar reflectors.

This lesson investigates properties of parabola; however, the focus is on applying parabolas to a genuine field of STEM. This lesson assumes students have engaged with at least some of Non-linear relationships A, Non-linear relationships B, and Non-linear relationships C (Path).

The properties of a parabola and its focus are explored beyond the scope of the Stage 5 syllabus.

### Syllabus content

* Explain that quadratic relationships are represented by parabolas
* Find the coordinates of a parabola’s vertex using a variety of methods

Table 5 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Para-solar (DOCX 2282 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l05-para-solar.docx)Duration: 2–3 lessonsLearning intentions* To be aware of an application of parabolas.
* To understand how the equation of a parabola effects its shape.

Success criteria* I can use technology to explore how the value of changes the shape of .
* I can conduct an experiment to demonstrate the relationship between the shape of a parabola and its focus.
 | * [*Para-solar* (PPTX 2.1 MB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l05-para-solar.pptx) PowerPoint
* One digital device per pair

**Prepare equipment for groups of 3:*** ‘Linear parabolic solar reflectors’ activity sheet from Liacos Educational Media (<https://bit.ly/solarreflectorsactivity>)
* Card
* A3 graph paper
* Scissors
* Glue
* Aluminium foil
* 2 cans
* 2 thermometers
* 3 retort stands
* 4 boss heads
* 4 clamps
* Sticky tape
* Rubber stopper (or an alternative to hold the rolled paper)
* Pencil

**Optional*** Class set of Appendix A, printed
 |  |

## Learning episode 6 – in a galaxy far, far away

### Teaching and learning activity

Students use graphing applications to explore transformations of hyperbolas.

### Syllabus content

* Use graphing applications to graph, compare and describe hyperbolic relationships of the form for integer values of
* Use graphing applications to graph and describe a variety of hyperbolas, including where the equation is given in the form or for integer values of and

Table 6 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [In a galaxy far, far away (DOCX 229 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l06-in-a-galaxy-far-far-away.docx)Duration: 1–2 lessonsLearning intention* To know how and affect the graph of

Success criteria* I can identify connections between the equation of a hyperbola and its graph.
* I can transform hyperbolae to meet given conditions.
 | * One digital device per pair
 |  |

## Learning episode 7 – breeding like rabbits

### Teaching and learning activity

Students will use online graphing software to explore the concept of exponential growth and decay.

### Syllabus content

* Use graphing applications to graph exponential relationships of the form and for integer values of , and (where and ) and compare and describe any relevant features
* Solve simple equations that involve exponents or logarithms
* Generalise that is an increasing function when and decreasing when

Table 7 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Breeding like rabbits (DOCX 244 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l07-breeding-like-rabbits.docx)Duration: 1–2 lessonsLearning intentions* To gain a deeper knowledge and understanding of exponentials, their features.
* To know how to transform exponential graphs using graphing applications.

Success criteria* I can graph an exponential relationship using graphing applications.
* I can use exponentials to describe and predict growth and decay.
* I can find the asymptote for an exponential and determine its equation.
* I can translate graphs of exponential relationships.
 | * Students will need at least one digital device with internet access, per pair
* Enough printed copies of Appendix A for student groups (enlarged where possible)
* Class set of Appendix B printed
 |  |

## Learning episode 8 – why vampires don’t exist

### Teaching and learning activity

Students explore a problem involving exponential growth to introduce the concept of logarithms.

### Syllabus content

* Define the term logarithm: the logarithm of a number to any positive base is the index to which is raised to give this number
* Translate statements expressing a number in index form into equivalent statements expressing the logarithm of the number
* Use graphing applications to compare and contrast graphs for the functions   and

Table 8 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Why vampires don’t exist (DOCX 323 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l08-why-vampires-dont-exist.docx)Duration: 1–2 lessonsLearning intention* To know how exponential equations and logarithms are related.

Success criteria* I can convert between exponential equations and logarithms.
* I can explain why logarithms are useful.
 | * [*Why vampires don’t exist* (PPTX 717.9 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l08-why-vampires-dont-exist.pptx) PowerPoint
* Class set of Appendix A, printed
 |  |

## Learning episode 9 – Where’s the pHun in that?

### Teaching and learning activity

Students will look at the idea of changing levels of acidity and basicity in a variety of substances as a context for exploring the use of logarithms.

### Syllabus content

* Recognise equivalence where is equivalent to where and
* Translate statements expressing a number in index form into equivalent statements expressing the logarithm of the number
* Examine logarithmic scales and explain their use in various contexts
* Solve simple equations that involve exponents or logarithms

Table 9 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Where’s the pHun in that? (DOCX 246 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l09-wheres-the-phun-in-that.docx)Duration: 1–2 lessonsLearning intention* To develop an understanding of the relationship between logarithms and indices.

Success criteria* I can apply my knowledge of logarithms to solve problems involving base 10.
* I can solve equations that involve exponents or logarithms.
 | * Students will need at least one digital device per pair to interact with online interactives
* [*Where’s the pHun in that?* (PPTX 792.6 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l09-wheres-the-phun-in-that.pptx) PowerPoint
* Enough clear, plastic, empty soft-drink bottles for 1 between every 3 students
* Class set of Appendix A and B, printed if access to technology is unavailable
* Class set of Appendix D, printed

**Optional*** Class set of Appendix C, printed
* pH testing kits – 1 between 3 students
* Hand trowels (or equivalent) – 1 between 3 students
 |  |

## Learning episode 10 – logging those sounds

### Teaching and learning activity

Students will build an understanding of how to use a logarithmic scale to better understand and apply logarithmic laws and properties.

### Syllabus content

* Deduce laws of logarithms from laws of indices
* Solve simple equations that involve exponents or logarithms
* Apply the laws of logarithms to evaluate and simplify expressions
* Establish and use a variety of logarithmic results

Table 10 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [Logging those sounds (DOCX 363 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l10-logging-those-sounds.docx)Duration: 2–3 lessonsLearning intention* To understand and apply logarithmic laws and properties.

Success criteria* I can use the addition law of logarithms.
* I can explain why the addition law works.
* I can use the subtraction law of logarithms.
* I can explain why the subtraction law works.
* I can use the power law of logarithms.
* I can explain why the power law works.
 | * One digital device per pair
* Enough centi-cubes for each group of 3 students to have 110
* [*Logging those sounds* (PPTX 3.2 MB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l10-logging-those-sounds.pptx) PowerPoint
* Class set of Appendix G and H, printed

**Optional*** If technology is unavailable, enough printed copies of Appendices A, B, C, D, E, and F for each group of 3 to work on at their vertical, non-permanent surfaces
 |  |

## Learning episode 11 – one small step IS one giant leap

### Teaching and learning activity

Students will explore how the application of a logarithmic scale approach can reduce the challenges of comparing extremely large and small values.

### Syllabus content

* Examine logarithmic scales and explain their use in various contexts
* Establish and use a variety of logarithmic results

Table 11 – lesson sequence and details

|  |  |  |
| --- | --- | --- |
| Visible learning | Required resources | Registration, adjustments and evaluation notes |
| [One small step IS one giant leap (DOCX 312 KB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l11-one-small-step-is-one-giant-leap.docx)Duration: 2–3 lessonsLearning intention* To understand and use logarithmic scales.

Success criteria* I can create a logarithmic scale with a base of 10.
* I can create a logarithmic scale with a base other than 10.
* I can convert a single logarithm into 2 logarithms.
* I can simplify 2 logarithms with the same base and create a single logarithm.
* I can solve problems on a log scale using the laws of logarithms.
 | * One digital device, with internet connectivity, per pair of students
* [*One small step IS one giant leap* (PPTX 2.2 MB)](https://education.nsw.gov.au/content/dam/main-education/en/home/teaching-and-learning/curriculum/mathematics/documents/mathematics-s5-e1-l11-one-small-step-is-one-giant-leap.pptx) PowerPoint
* Enough copies ofAppendix A, printed on A3, for each group of three students

**Optional*** To finish off the Apply section, several different sized spherical balls to recreate a scale model of the solar system in a large space such as an oval or sports court/field
 |  |

# References

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NESA (NSW Education Standards Authority) (2022) ‘[Programming](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming)’, Understanding the curriculum, NESA website, accessed 31 May 2023.

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