# Mathematics Stage 5 Year 9 – index laws



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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.

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](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming) 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](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming/advice-on-units) page. 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 Core focus areas of Indices A and Numbers of any magnitude as well as Path focus areas of Indices B and Indices C. The lessons and sequences in this program of learning are designed to allow students to explore the index laws and apply them both numerically and algebraically.

**Duration:** this program of learning is designed to be completed over a period of approximately 3 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**
* simplifies algebraic expressions involving positive-integer and zero indices and establishes the meaning of negative indices for numerical bases **MA5-IND-C-01**
* solves measurement problems by using scientific notation to represent numbers and rounding to a given number of significant figures **MA5-MAG-C-01**

### Path

**A student:**

* applies the index laws to operate with algebraic expressions involving negative-integer indices **MA5-IND-P-01**
* describes and performs operations with surds and fractional indices **MA5-IND-P-02**

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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 – invaluable indices

#### Teaching and learning activity

Students investigate and review the multiplication, division, power of a power and zero index laws and apply them to numerical bases. This lesson is designed to revisit the concepts covered in Stage 4.

#### Syllabus content

* Apply the index laws for numerical bases with positive-integer indices to develop the index laws in algebraic form
* Simplify algebraic expressions that involve powers, products and quotients of simple algebraic terms containing positive-integer indices

**Table 1 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [Invaluable indices](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-01-invaluable-indices.docx)Duration: 1 lessonLearning intention* To understand how to apply the index laws to simplify calculations.

Success criteria* I can simplify numerical expressions using the multiplication index law.
* I can simplify numerical expressions using the division index law.
* I can simplify numerical expressions using the power of a power index law.
* I can simplify numerical expressions using the zero-index law.
 | * [*Invaluable indices* PowerPoint](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-01-invaluable-indices.pptx)
* Class set of Appendix A, B, G and H, printed
* A quarter of the class set of Appendix C, D, E and F, printed
 |  |

### Learning episode 2 – mathematical shorthand

#### Teaching and learning activity

Students discover the need for, and learn about scientific notation for large numbers by examining distances and weights of planets in our solar system.

#### Syllabus content

* Recognise the need for notation to express very large or very small numbers
* Represent numbers using scientific notation in practical contexts
* Order numbers expressed in scientific notation
* Represent numbers expressed in scientific notation as a decimal

**Table 2 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [Mathematical shorthand](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-02-maths-shorthand.docx)Duration: 1 lessonLearning intention* To be able to express large numbers in scientific notation.

Success criteria* I can recognise when a number is written in scientific notation
* I can convert large numbers in decimal form to scientific notation.
* I can convert large numbers in scientific notation to decimal form.
* I can enter numbers into my calculator when in scientific notation
 | * [*Mathematical shorthand* PowerPoint](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-02-mathematical-shorthand.pptx)
* Class set of Appendix A, B, C and D, printed
 |  |

### Learning episode 3 – How many trips to the moon?

#### Teaching and learning activity

Students investigate the relationships between very large measurements to examine the usefulness of expressing large numbers in scientific notation for operations.

#### Syllabus content

* Estimate the value of calculations involving scientific notation by applying knowledge of index laws
* Solve problems with calculations involving scientific notation using digital tools

**Table 3 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [How many trips to the moon?](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-03-trips-to-the-moon.docx) Duration: 1 lessonLearning intention* To be able to operate with large numbers expressed in scientific notation.

Success criteria* I can multiply large numbers expressed in scientific notation.
* I can divide large numbers expressed in scientific notation.
* I can round the decimal part of numbers in scientific notation to simplify approximate calculations.
 | * Class set of Appendix A, B and C, printed
 |  |

### Learning episode 4 – growing with power

#### Teaching and learning activity

Students investigate the multiplication and power of a power index laws to apply them to algebraic bases.

#### Syllabus content

* Apply the index laws for numerical bases with positive-integer indices to develop the index laws in algebraic form
* Simplify algebraic expressions that involve powers, products and quotients of simple algebraic terms containing positive-integer indices

**Table 4 – Lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [Growing with power](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-04-growing-with-power.docx) Duration: 1 lessonLearning intention* To be able to use the multiplication index law to simplify algebraic expressions.
* To be able to use the power of a power index law to simplify algebraic expressions.

Success criteria* I can identify the power and the base of a number written in index form.
* I can simplify algebraic expressions using the multiplication index law.
* I can simplify algebraic expressions using the power of a power index law.
 | * Class set of Appendix A and B, printed
* Appendix C printed as an extension
 |  |

### Learning episode 5 – let’s power down

#### Teaching and learning activity

Students investigate the dividing and zero index laws to apply them to algebraic bases.

#### Syllabus content

* Apply the index laws for numerical bases with positive-integer indices to develop the index laws in algebraic form
* Establish that $x^{0}=1$ algebraically using index laws
* Simplify algebraic expressions that involve the zero index
* Simplify algebraic expressions that involve powers, products and quotients of simple algebraic terms containing positive-integer indices
* Apply the index laws to simplify algebraic products and quotients involving negative-integer indices (Path)

**Table 5 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [Let’s power down](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-05-lets-power-down.docx)Duration: 1 lessonLearning intention* To be able to use the division index law to simplify algebraic expressions.
* To be able to simplify algebraic expressions that involve the zero index.

Success criteria* I can simplify fractions by dividing by a common factor.
* I can simplify algebraic expressions using the division index law.
* I can simplify algebraic expressions using the zero index law.
 | * 1 copy of Appendix A, printed and cut into cards
* 9 counters per student
* [*Let’s Power Down* PowerPoint](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-05-lets-power-down.pptx)
 |  |

### Learning episode 6 – reflecting on practice

#### Teaching and learning activity

This lesson contains a variety of activities that allow students to practise simplifying algebraic expressions using index laws.

#### Syllabus content

* Apply the index laws for numerical bases with positive-integer indices to develop the index laws in algebraic form
* Simplify algebraic expressions that involve the zero index
* Simplify algebraic expressions that involve powers, products and quotients of simple algebraic terms containing positive-integer indices

**Table 6 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [Reflecting on practice](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-06-reflecting-on-practice.docx)Duration: 1 lessonLearning intention* To be able to consistently apply the index laws to simplify expressions.
* To understand how the index laws apply to a variety of situations.

Success criteria* I can identify the index law(s) required to simplify an expression.
* I can explain why an expression simplifies in a particular way.
 | * Class set of Appendix A, B and C, printed
 |  |

### Learning episode 7 – mathematical shorthand continued

#### Teaching and learning activity

Students investigate the width of atoms and other very small objects to discover the need for, and learn about scientific notation for very small numbers.

#### Syllabus content

* Recognise the need for notation to express very large or very small numbers
* Represent numbers using scientific notation in practical contexts
* Order numbers expressed in scientific notation
* Represent numbers expressed in scientific notation as a decimal
* Solve problems with calculations involving scientific notation using digital tools

**Table 7 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [Mathematical shorthand continued](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-07-maths-shorthand-cont.docx)Duration: 1 lessonLearning intention* To be able to express very small numbers in scientific notation.

Success criteria* I can convert very small numbers in decimal form to scientific notation.
* I can convert very small numbers in scientific notation to decimal form.
* I can order numbers represented in scientific notation.
 | * [*Mathematical shorthand continued*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-07-mathematical-shorthand-continued.pptx) PowerPoint
* Class set of Appendix A, B and C, printed
 |  |

### Learning episode 8 – half-life

#### Teaching and learning activity

Students investigate half-life to establish the need for and meaning of negative indices for numerical bases. Students also use the change from positive to negative indices to reinforce the zero index.

#### Syllabus content

* Apply index notation, patterns and index laws to establish the meaning of negative indices for numerical bases
* Evaluate numerical expressions involving a negative index by first representing them with a positive index
* Represent given numbers in index form (integer indices and bases only) and vice versa

**Table 8 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [Half-life](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-08-half-life.docx)Duration: 1–2 lessonLearning intention* To understand the relationship between positive and negative indices.

Success criteria* I can express terms with a negative power as a fraction.
* I can express fractions as a term with a negative power.
* I can simplify expressions with a zero index.
 | * Multi-coloured, button-shaped chocolates, coated in hard candy with a letter on one side (or counter with a mark on one side)
* Plastic cups
* Class set of Appendix A, B, C and D, printed
* Device per pair of students (or graphing paper)
* [*Half-life*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-08-half-life.pptx) PowerPoint
 |  |

### Learning episode 9 – that’s Ab-SURD

#### Teaching and learning activity

Students explore fractional powers and their relationship to surds.

#### Syllabus content

* Apply index laws to describe fractional indices as: $a^{\frac{1}{n}}=\sqrt[n]{a}$ and $a^{\frac{m}{n}}=\sqrt[n]{a^{m}}=\left(\sqrt[n]{a}\right)^{m}$
* Translate expressions in surd form to expressions in index form and vice versa
* Evaluate numerical expressions involving fractional indices including using digital tools

**Table 9 – lesson details**

|  |  |  |
| --- | --- | --- |
| Visible learning | Required Resources | Registration, adjustments and evaluation notes |
| [That’s ab-SURD](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-09-thats-ab-surd.docx)Duration: 1 lessonLearning intention* To understand that a number with a fractional index can be written as a surd.

Success criteria* I can use known index laws to explain the meaning of fractional indices.
* I can express a surd as a number with a fractional index.
* I can express a number with a fractional index as a surd value.
* I can solve problems that involve fractional indices.
 | * [*That’s Ab-SURD*](https://education.nsw.gov.au/content/dam/main-education/en/home/schooling/curriculum/mathematics/mathematics-s5-unit-04-lesson-09-thats-ab-surd.pptx)  PowerPoint
* Class sets of Appendix A, B, C and D, printed
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## References

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