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| Indices | Mathematics Stage 5.3  |

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| Summary of Substrands | Duration: 3 weeks |
| Indices MA4-9NA Indices MA5.1-5NA Indices MA 5.2-7NA | Start Date: |
| Completion Date: |
| Teacher and Class: |
| Outcomes |
| * MA5.3‑1WM uses and interprets formal definitions and generalisations when explaining solutions and/or conjectures
* MA5.3‑2WM generalises mathematical ideas and techniques to analyse and solve problems efficiently
* MA5.3‑3WM uses deductive reasoning in presenting arguments and formal proofs
* MA5.3‑6NA performs operations with surds and indices
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| Overview | Key Words | Suggested Assessment  |
| Students work on simplifying more difficult algebraic expressions and use negative indices and zero indices. | Positive, negative, indices, index, base, exponent, reciprocal, surd rational, irrational, real numbers.There is a need to emphasise to students how to read and articulate surds and fractional indices, eg$ \sqrt{x}$ is the square root of x or root x | Test Quick questionsObservations |

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| Rego | Content | Teaching, learning and assessment  | Resources  |
|  | Stage 5.3 - Surds and Indices §Students:Define rational and irrational numbers and perform operations with surds and fractional indices (ACMNA264)* define real numbers: a real number is any number that can be represented by a point on the number line
* define rational and irrational numbers: a rational number is any number that can be written as the ratio  of two integers a and b where ; an irrational number is a real number that is not rational
* recognise that all rational and irrational numbers are real (Reasoning)
* explain why all integers, terminating decimals and recurring decimals are rational numbers (Communicating, Reasoning)
* explain why rational numbers can be expressed in decimal form (Communicating, Reasoning)
* use a pair of compasses and a straight edge to construct simple rational numbers and surds on the number line (Problem Solving)
* distinguish between rational and irrational numbers
* demonstrate that not all real numbers are rational (Problem Solving)
* use the term 'surd' to refer to irrational expressions of the form  where  is a rational number and   is an integer such that
* write recurring decimals in fraction form using calculator and non-calculator methods,eg , ,
* justify why  (Communicating, Reasoning)
* demonstrate that  is undefined for x <  0 and that  for x = 0
* define  as the positive square root of x for x > 0
* use the following results for x > 0 and y > 0:
* apply the four operations of addition, subtraction, multiplication and division to simplify expressions involving surds
* explain why a particular sentence is incorrect, eg explain why  (Communicating, Reasoning)
* expand expressions involving surds, eg expand ,
* connect operations with surds to algebraic techniques (Communicating)
* rationalise the denominators of surds of the form
* investigate methods of rationalising surdic expressions with binomial denominators, making appropriate connections to algebraic techniques (Problem Solving)
* recognise that a surd is an exact value that can be approximated by a rounded decimal
* use surds to solve problems where a decimal answer is insufficient, eg find the exact perpendicular height of an equilateral triangle (Problem Solving)

establish that * apply index laws to demonstrate the appropriateness of the definition of the fractional index representing the square root, eg
* explain why finding the square root of an expression is the same as raising the expression to the power of a half (Communicating, Reasoning)
* apply index laws to demonstrate the appropriateness of the following definitions for fractional indices: ,
* translate expressions in surd form to expressions in index form and vice versa
* use the  or equivalent key on a scientific calculator

evaluate numerical expressions involving fractional indices, eg  | Students review work from Stage 4 and 5.1 and 5.2 on index lawsSome HistoryThe term surd traces back to [al-Khwārizmī](http://en.wikipedia.org/wiki/Khw%C4%81rizm%C4%AB) (c. 825), who referred to rational and irrational numbers as audible and inaudible, respectively. This later led to the Arabic asamm (deaf, dumb) for irrational number being translated as surdus (deaf or mute) into Latin. Gherardo of Cremona (c. 1150), Fibonacci (1202) and then Robert Recorde (1551) all used the term to refer to unresolved irrational roots [From wikipedia]**Introducing Surds**Remind students of exact answers when finding the length of sides using PythagorasExact answers are needed in building Revise Pythagoras so students have an understanding of exact values surdsMacintosh HD:Users:maureenmilgate:Desktop:Screen Shot 2013-08-13 at 10.34.09 AM.pngStudents are given numbers and asked to place them on the layers, 5,  , 7 , , , 0. $\dot{3.}$Explain rational and irrational numbersMacintosh HD:Users:maureenmilgate:Desktop:Screen Shot 2013-08-13 at 11.43.38 AM.pngl numbersMacintosh HD:Users:maureenmilgate:Desktop:Screen Shot 2013-08-13 at 11.48.08 AM.png Watch video on recurring decimals in fraction formDeliberate practiceWatch video why 0.9 = 1Use calaculator and try to find the square root of negative numbers and discuss why it comes up with an error thus leading to the positive square root.Use calculator to demonstrate and explain when you square a square root you get the integerDeliberate practiceSimplify surdsStudents write the first 12 square numbers and look for the square number in the surd to simplifyAdding and subtracting surds must have like surds relate it to algebraDeliberate practiceMultiplying and dividing surds Deliberate practiceWatch video rationalizing surdsDeliberate practiceWatch video on fractional indicesFractional indices Practice changing from surds to fractional indices | **Work sheet** Review Stage 4 and 5.1 with a work sheet or text bookGame to reinforce indices<http://www.bbc.co.uk/schools/gcsebitesize/maths/activities/flash/snap_powers/snap_powers.shtml><http://www.bbc.co.uk/schools/gcsebitesize/maths/number/powersroots/quiz/q89452185/><http://www.tes.co.uk/teaching-resource/Laws-of-Indices-Treasure-Hunt-KS3-GCSE-6068454/><http://www.youtube.com/watch?v=TGzIpq944Cc>http://www.youtube.com/watch?v=79Q08UYknTYhttp://www.youtube.com/watch?v=79Q08UYknTYhttp://www.youtube.com/watch?v=kCnba1bV4lE |

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| Evaluation  | Adjustment |
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