4 Indices and surds

Syllabus content	Suggested teaching activities
Whole unit	We recommend that learners cover this unit before **14 Differentiation and Integration** since converting from roots to powers is a commonly required skill. We also recommend that learners cover this topic before **7 Logarithmic and Exponential Functions**. Covering this unit before **8 Straight line graphs** will prepare learners for transforming relationships to straight line form. Learners will have some experience of manipulating index terms through their studies in Cambridge O Level Mathematics or IGCSE Mathematics. They will also have met surds when dealing with irrational numbers. Ideally they should be well practised in algebraic techniques for binomial terms – such as the difference of two squares – as this knowledge is also mirrored in this topic. Questions may be set in geometric or algebraic contexts. Learners will need to recall how to find the area and perimeter of shapes such as triangles, rectangles, trapezia and circles. Learners will also need to know how to solve simple equations. Knowledge of basic trigonometry may need to be applied to such questions. This unit builds on skills learners should already have covered in Cambridge O Level Mathematics or IGCSE Mathematics. The examples and questions should be more challenging as learners take a step up in their level of mathematics. It is essential that learners understand that they must show sufficient working to demonstrate that they have fully understood the techniques, rather than relying on their calculator for surd work. Learners should be encouraged to use their calculator only as a checking tool in questions assessing surds.
• perform simple operations with indices and with surds, including rationalising the denominator	Learners will need to revise their knowledge of indices and then develop skills in manipulating surds. Use examples that can be shown to be true using the index laws, in order to convince your learners. Revision and practice exercises are important. **(I)** The 'Surds' exercise at: www.mathsisfun.com/surds.html can be used to reinforce the concept of a surd and give learners some quick practice. It could be used as a starter activity with an advanced group or as a teacher-led activity with a group that needs more support. Learners will need to appreciate algebraically as well as numerically that $\sqrt{a}\times\sqrt{b}=\sqrt{ab}$ and vice versa and also $\frac{\sqrt{a}}{\sqrt{b}}=\sqrt{\frac{a}{b}}$ and vice versa. Rationalising the denominator is a new skill dictated purely by mathematical convention. Revise the difference of two squares to show why, for example $1+\sqrt{3}$ is the multiplier to use in order to rationalise $1-\sqrt{3}$. Make sure that

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	learners appreciate that multiplying both the numerator and the denominator by the 'same' number with opposite sign (the square root conjugate) means that the original expression is being multiplied by a strategic form of 1 and therefore identity is maintained. Use an investigative approach, so that learners discover what rationalising the denominator is all about and why we do it, as well as manipulating expressions with surds. Start with questions such as: simplify $\sqrt{18}$, $4\sqrt{18}-3\sqrt{18}$, $2\sqrt{75}$ to lowest terms. Move on to consider how to simplify terms such as $\sqrt{2}(5-\sqrt{8})$ and then to simplification of expressions such as $\left(2+\sqrt{8}\right)^2$. This will ensure that the level of difficulty is built up gradually. Use an example such as: Simplify each of the following and hence show that all three expressions are equal: (i) $\frac{\sqrt{32}}{4}$ (ii) $4\sqrt{2}-\sqrt{18}$ (iii) $\frac{\sqrt{10}}{\sqrt{5}}$. Start rationalising with single surd denominators, e.g. Write $\frac{3}{\sqrt{5}}$ with a rational denominator. Then extend to binomial terms in the numerator e.g. $\frac{3+\sqrt{5}}{\sqrt{5}}$ and then to binomial terms in both the numerator and denominator, e.g. $\frac{3+\sqrt{5}}{1+\sqrt{5}}$. When learners have acquired the basic skills they can move on to more involved expressions such as $\frac{(3+\sqrt{5})^2}{1+\sqrt{5}}$. When learners have mastered the numerical skills, they can move onto the more challenging skill of applying the laws of indices and roots to algebraic expressions and equations, e.g. Simplify $\frac{\sqrt{4x-3}+(4x-3)^{-\frac{3}{2}}}{\sqrt{4x-3}}$ to solve $\frac{\sqrt{4x-3}+(4x-3)^{-\frac{3}{2}}}{\sqrt{4x-3}}=\frac{5}{4}$

Past and specimen papers

Past/specimen papers and mark schemes are available to download at www.cambridgeinternational.org/support **(F)**

2020 Specimen Paper 1 Q4
Nov 2017 Paper 22 Q1, Q2; Nov 2017 Paper 23 Q3
Jun 2017 Paper 11 Q3 (including 7 Logarithmic and exponential functions); Jun 2017 Paper 13 Q4; Jun 2017 Paper 21 Q2; Jun 2017 Paper 22 Q2;
Jun 2017 Paper 23 Q1b
Mar 2017 Paper 22 Q5
Nov 2016 Paper 11 Q2; Nov 2016 Paper 13 Q2; Nov 2016 Paper 21 Q2; Nov 2016 Paper 23 Q1; Nov 2016 Paper 23 Q5
Jun 2016 Paper 12 Q4 (including 2 Quadratic functions); Jun 2016 Paper 21 Q5
Mar 2016 Paper 12 Q2; Mar 2016 Paper 22 Q6
Mar 2015 Paper 12 Q10