# Teacher Delivery Guide: Algebra (AL)

| **Content** |  | **Learners should be able to** | **Notes** |
| --- | --- | --- | --- |
| **Algebra (AL)** |  |  |  |
| Algebraic Manipulation | AL1 | Know and use algebraic vocabulary and notation. | i.e. constant, coefficient, expression, equation, identity, index, variable, unknown,  . |
|  | AL2 | Simplify expressions involving algebraic fractions and square roots. | e.g. Simplify .e.g. Simplify . |
|  | AL3 | Perform operations with polynomials, including addition, subtraction, multiplication and division.  | e.g.. |
|  | AL4 | Find linear factors of a polynomial. | Includes the use of the factor theorem. |
|  | AL5 | Complete the square of a quadratic polynomial. |   |
| Applications of equations | AL6 | Set up and solve problems leading to linear, quadratic and cubic equations in one unknown, and to simultaneous equations in two unknowns.  | Problems could be set in mathematical or non-mathematical contexts. |
| ***DISCLAIMER***This resource was designed using the most up to date information from the specification at the time it was published. Specifications are updated over time, which means there may be contradictions between the resource and the specification, therefore please use the information on the latest specification at all times.If you do notice a discrepancy please contact us on the following email address: resources.feedback@ocr.org.uk |
| Inequalities | AL7 | Manipulate inequalities. | e.g.   |
| AL8 | Set up and solve linear and quadratic inequalities algebraically and graphically. | e.g. solve  |
| AL9 | Illustrate linear inequalities in two variables. | i.e. the use of appropriate shading. |
| Recurrence relationships | AL10 | Understand and use notation of recurrence relationships to describe and determine sequences. | e.g. , ,  |
|  | AL11 | Use recurrence relationships in modelling.  | e.g. modelling compound interest |

### General Approach

Prior to working with the subject content of this section of the specification, it is essential that learners have gained a thorough understanding of a number of topics at GCSE level such as the four rules of number including the priority of operations, signed numbers, fractions, algebra including substitution, bracket expansion, simplification of terms and factorisation, products, factors, index notation, graphs and transformations.

Learners’ understanding should be deepened by a hands-on approach to this subject as they tend to struggle with the algebra involved.

### Prior knowledge

This section relies on the numeric and algebraic skills developed in the GCSE (9 – 1) course, and ability to apply these skills across the geometric and statistical sections, especially in the problem solving style questions at the higher level of demand.

### Misconceptions

When simplifying rational expressions, learners make errors related to their prior knowledge on common factions. As they try to simplify the rational expressions, learners follow certain procedures without full understanding. As the learners do so, they retrieve wrong or incomplete rules that lead them to make errors. The most common errors and misconceptions learners make due to their prior knowledge on simplifying common fractions are errors to do with cancellation, partial cancellation and like terms.

A common misconception when using surds is to think that  and many learners find the concept  very challenging.

Performing operations on polynomial expressions requires learners to have a high level of skills in algebra. As the foundation of algebra is basic arithmetic, many misconceptions in algebra are found to be rooted in misconceptions in arithmetic. Learners have difficulty recognising that the properties and operations for integers is the same as that for polynomials.

A common misconception when manipulating polynomials algebraically is failing to understand that two expressions that appear to be different can still be equivalent. Many learners struggle to recognise that.

One common misconception when working with quadratic functions is that learners only give the positive value as the square root of a positive number. They tend to forget about the negative value being a solution as well.

Also when solving an equation such as, often they are able to factorise and get  and then just give the solution and forget about the solution.

Learners often make mistakes when completing the square when the coefficient of  is not .

Many learners fail to realise that completing the square of a quadratic function reveals the maximum or minimum value of the function it defines.

Some learners might not be able to find integer solutions when solving quadratic functions and therefore conclude that no solutions exist.

Many learners find the solving of a quadratic equation very difficult but even when they do manage to solve the quadratic equation; they still do not always possess an understanding of the meaning of their solutions. Very often when learners are given quadratic word problems, they have difficulty comprehending the context and are unable to formulate the equation to be solved.

Very often when learners are solving simultaneous equations, they make a minor algebraic error or a transposition error.

A persistent misconception when solving inequalities is expressing inequalities as equations. As many learners think that inequalities and equations require the same mathematical solution process, they treat problems involving inequalities in exactly the same manner as equations, and assume the questions require similar processes. Very often learners treat inequalities as equations and solve the equations then they simply put the sign back. Learners often forget the rule that multiplying and dividing by a negative number changes the direction of the inequality.

Also, even when learners find the solution to inequalities, they do not always possess an understanding of the meaning of their solutions.

### Progression

This initial algebra section underpins the whole FSMQ programme. It is also the foundation for further study at AS/A Level Maths and Further Maths.

# Thinking Contextually

Aspects of this algebra section should be returned to regularly throughout the GCSE and FSMQ course since a confidence with algebraic manipulation, and solving equations and inequalities will be needed across the rest of the content, especially in the context of problem solving.

Many learners fail to make connections between what they are learning and how that knowledge will be used. They can struggle to understand the concepts in mathematics unless they can see the relevance to their everyday lives.

Learners will be more successful if they investigate mathematics through real-life scenarios as they can see how these concepts are actually used outside of the classroom. They will then be able to discover the meaningful relationship between abstract ideas and practical applications in the real world. This in turn will lead to greater motivation, enjoyment through discovery, improved confidence, independent thinking and better retention of skills.

# Resources

| **Title** | **Organisation** | **Description** | **Ref** |
| --- | --- | --- | --- |
| [Corbett’s Conundrums 3rd Jan](https://corbettmaths.files.wordpress.com/2014/08/january-3.pdf) | Corbett Maths | Short puzzle looking at divisibility of the sum of consecutive numbers. | AL1 |
| [Corbett’s Conundrum 12th Feb](https://corbettmaths.files.wordpress.com/2014/08/february-12.pdf) | Corbett Maths | Short algebra puzzle looking at rule for identifying 3 digit numbers divisible by 9. | AL1 |
| [Corbett’s Conundrum 13th Feb](https://corbettmaths.files.wordpress.com/2014/08/february-13.pdf) | Corbett Maths | Prime number investigation | AL1 |
| [Lesson Element Using and manipulating Surds](http://www.ocr.org.uk/Images/308610-topic-1.02b-lesson-element-surds.doc) | OCR | 3 Learner activitiesTask 1 Card Matching equivalent surd expressionsTask 2 Card Matching equivalent fractions involving surds and rationalising the denominatorTask 3 What’s the question challenge | AL2 |
| [Surds](https://revisionmaths.com/advanced-level-maths-revision/pure-maths/algebra/surds) | Revision Maths | This introductory resource covers the addition, subtraction, multiplication and division of surds. | AL2 |
| [Surds](http://mathematics.laerd.com/maths/surds-intro.php) | Laerd Mathematics | This excellent interactive resource is an introduction to surds. It includes twenty questions for learners to complete along with detailed solutions.  | AL2 |
| [Surds and Other Roots](http://www.mathcentre.ac.uk/resources/uploaded/mc-ty-surds-2009-1.pdf) | Mathscentre | This comprehensive resource covers surds and demonstrates how to simplify and rationalise expressions containing surds. It includes worked examples and exercises for the learners to complete along with answers. | AL2 |
| [Relevance Of Surds](https://www.youtube.com/watch?v=4K5y2K83Zrc) | Maths With Jacob | This short video resource highlights some areas where surds are used in real life.  | AL2 |
| [Surds – Application To Adding / Subtracting](https://www.youtube.com/watch?v=o1Jm6HaUWWo) | Dani Wright | This short video resource looks at a real-life application of adding surds.  | AL2 |
| [The Root of the Problem](https://nrich.maths.org/901) | Nrich | Puzzle involving the sum of surds | AL2 |
| [Venn Diagrams 17 - Surds](https://www.tes.com/teaching-resource/venn-diagrams-17-surds-11074234) | Mr Barton | Set of Venn Diagram puzzles using surd criteria  | AL2 |
| [Surds inquiry](http://www.inquirymaths.com/home/number-prompts/surds) | Enquiry Maths | Investigate   | AL2 |
| [Algebraic Fractions 1 - Simplifying, Adding & Subtracting](https://www.youtube.com/watch?v=WAmTNO2hNcY) | ukmathsteacher | 30 minute video looking at simplifying algebraic fractions and common errors | AL2 |
| [Simplifying algebraic fractions.](https://www.youtube.com/watch?v=NC9oInojrDI) | Graham Walton | 11 minute video looking at factorising and simplifying algebraic fractions involving quadratic terms | AL2 and AL3 |
| [Polynomials](https://www.youtube.com/watch?v=wkP1Gkl-gfk) | mathstutorbiz | This excellent video resource demonstrates how to add, subtract and multiply polynomials. | AL3 |
| [Polynomial Division & Equating Coefficients](https://www.youtube.com/watch?v=Gu5xF0CSJmk) | ukmathsteacher | This challenging video resource demonstrates how to divide polynomials. | AL3 |
| [Polynomial Division](http://www.mathtutor.ac.uk/algebra/polynomialdivision/text) | mathtutor | This comprehensive resource covers polynomial division. It includes a video tutorial, worked examples and exercises for the learners to complete.  | AL3 |
| [How to divide polynomials using long division](https://www.youtube.com/watch?v=smsKMWf8ZCs) | MySecretMathTutor | Dividing Polynomials using formal long division method. 9 minute video. | AL3 |
| [How to Divide Polynomials Using the Box Method](https://www.youtube.com/watch?v=OhJ5s55j__Q) | Synonym Classroom | Alternate method for dividing polynomials using the reverse of the box multiplication method. 3 minute video demonstration.  | AL3 |
| [The Factor Theorem](https://www.youtube.com/watch?v=6G3iAgpK4kA) | ExamSolutions | This excellent video resource introduces learners to the factor theorem. | AL4 |
| [Factor and Remainder Theorem](https://www.youtube.com/watch?v=Gu5xF0CSJmk) | ukmathsteacher | This challenging video resource covers the factor and remainder theorem. | AL4 |
| [Polynomials](http://www.s-cool.co.uk/a-level/maths/advanced-algebra/revise-it/polynomials) | S-cool | This concise resource looks at polynomials and the factor theorem. | AL4 |
| [Factor/Remainder Theorem](https://www.geogebra.org/m/nTZksysr) | Geogebra | Uses a slider to demonstrate the factor theorem | AL4 |
| [Completing the Square Example](https://www.youtube.com/watch?v=lS0ork9JvSc) | Exam Solutions | This excellent video resource demonstrates how to complete the square of the quadratic polynomial   | AL5 |
| [Completing The Square](http://www.mathcentre.ac.uk/resources/uploaded/mc-ty-completingsquare2-2009-1.pdf) | Mathscentre | This comprehensive resource covers completing the square. It includes worked examples and exercises for the learners to complete along with answers. | AL5 |
| [Completing the Square](https://www.youtube.com/watch?v=FD7vZ5jt0yg) | Exam Solutions | This excellent video resource demonstrates how to complete the square of the quadratic polynomial   | AL5 |
| [How to Complete the Square For Quadratics](https://www.youtube.com/watch?v=8oVmtQ88gt0) | Foxmaths | This excellent video resource demonstrates how to complete the square using two examples. | AL5 |
| [Completing the Square](http://www.nuffieldfoundation.org/sites/default/files/files/FSMA%20Completing%20the%20square%20student.pdf) | Nuffield foundation | This concise resource demonstrates how to complete the square of the quadratic polynomial and highlights an application of completing the square. | AL5 |
| [Completing The Square](http://www.mathsmutt.co.uk/files/com%20squares.htm) | Maths Mutt | This excellent resource demonstrates how to complete the square using numerous detailed examples. | AL5 |
| [Celebrity Misconceptions: Completing the Square](https://goalbookapp.com/pathways/#!/resources/3a55988b-fb64-41d5-665d-b2c4e1227257) | Goalbook Pathways | This resource helps to address the misconceptions in completing the square. | AL5 |
| [some wrong equation solving](http://4.bp.blogspot.com/-wDLzGgA6TY8/T1JPSiVCHTI/AAAAAAAADmU/vVlkKj1malU/s1600/Picture1.png) | Don Stewart | Set of incorrect equation solutions designed to focus on common algebra misconceptions. Students to rewrite correctly. | AL6 |
| [Corbett’s Conundrum 19th Feb](https://corbettmaths.files.wordpress.com/2014/08/february-19.pdf) | Corbett Maths | Short area based puzzle | AL6 |
| [Corbett’s Conundrum 3rd Feb](https://corbettmaths.files.wordpress.com/2014/08/february-3.pdf) | Corbett Maths | Linear equation puzzle involving fractions | AL6 |
| [Corbett’s Conundrum 11th Jan](https://corbettmaths.files.wordpress.com/2014/08/january-111.pdf) | Corbett Maths | Short puzzle leading to a quadratic equation to be solved. | AL6 |
| [quadratic expression versions](https://2.bp.blogspot.com/-XDL_y3d9Qcw/Whmnrc07TQI/AAAAAAAAWDw/BbOAdtDbEcwKDk3jSRqOa7wFgZN1De1IACLcBGAs/s1600/Picture1.png) | Don Stewart | Find the unknown variables to make each set of quadratic expressions equivalent.  | AL6 |
| [What is a Quadratic Equation?](http://www.virtualnerd.com/algebra-1/quadratic-equations-functions/graphing-solutions/graphing-solution-definitions-examples/equation-definition) | Virtual Nerd | This video resource introduces learners to quadratic equations and the methods of solving them. | AL6 |
| [What is the Discriminant?](http://www.virtualnerd.com/algebra-1/quadratic-equations-functions/discriminant-quadratic-formula/discriminant/discriminant-definition) | Virtual Nerd | This video resource introduces learners to the method of calculating the discriminant of a quadratic equation.  | AL6 |
| [Quadratic Theory: The Discriminant](http://www.bbc.co.uk/bitesize/higher/maths/algebra/quadratic_theory/revision/4/) | BBC | This excellent resource introduces learners to the discriminant of quadratic equations and determines the number and nature of the roots. | AL6 |
| [How do you find the Discriminant of a Quadratic Equation with 2 solutions?](http://www.virtualnerd.com/algebra-1/quadratic-equations-functions/discriminant-quadratic-formula/discriminant/discriminant-two-solutions-example) | Virtual Nerd | This video resource demonstrates how to calculate the discriminant of a quadratic equation. | AL6 |
| [Discriminants and Determining the Number of Real Roots of a Quadratic Equation](https://www.mytutor.co.uk/answers/801/A-Level/Maths/Discriminants%2Band%2Bdetermining%2Bthe%2Bnumber%2Bof%2Breal%2Broots%2Bof%2Ba%2Bquadratic%2Bequation) | My tutor | This excellent short resource introduces learners to the discriminant of quadratic equations and determines the number and nature of the roots. It includes four questions for learners to attempt, along with answers. | AL6 |
| [Examples on the Nature of Roots of a Quadratic Equation](https://www.youtube.com/watch?v=zepJRXw-3o4) | Exam Solutions | This excellent video resource demonstrates how to use the discriminant to determine the number and nature of the roots of the quadratic equation and then relates the results to a graph. | AL6 |
| [Quadratic Functions and Equations](http://www.bbc.co.uk/education/guides/zs9wxnb/revision/7) | BBC | This concise, interactive resource demonstrates how to calculate the discriminant of quadratic equations and determine the nature of the roots. It includes a test of 12 questions and the learners can check their score. | AL6 |
| [Solving Quadratics by Factorising](https://corbettmaths.com/2013/05/03/solving-quadratics-by-factorising/) | Corbettmaths | This excellent video resource demonstrates how to solve quadratics by factorising. | AL6 |
| [Exam Questions – Roots and Discriminant](https://www.examsolutions.net/tutorials/exam-questions-roots-and-discriminant/) | Exam Solutions | This interactive resource offers learners the opportunity to practice their understanding of quadratic equations (including the discriminant and roots) to help address some misconceptions.  | AL6 |
| [Solve Quadratic Equations Using Discriminants](http://www.analyzemath.com/Equations/Quadratic-1.html) | Free Mathematics Tutorials | This interactive resource offers learners the opportunity to practice solving quadratic equations using discriminants to help address some misconceptions. | AL6 |
| [Roots of a Quadratic Equation: Discriminant](https://www.youtube.com/watch?v=awL6Znlemoo) | ExamSolutions | This excellent video resource demonstrates how to solve quadratic equations using the quadratic formula. It then demonstrates how to use the discriminant to determine the number and nature of the roots of the quadratic equation and then relates the results to a graph. | AL6 |
| [Examples on the Nature of Roots of a Quadratic Equation](https://www.youtube.com/watch?v=zepJRXw-3o4) | ExamSolutions | This excellent video resource demonstrates how to use the discriminant to determine the number and nature of the roots of the quadratic equation and then relates the results to a graph. | AL6 |
| [Roots of a Quadratic Equation: Discriminant](https://www.youtube.com/watch?v=awL6Znlemoo) | Exam Solutions | This excellent video resource demonstrates how to solve quadratic equations using the quadratic formula. It then demonstrates how to use the discriminant to determine the number and nature of the roots of the quadratic equation and then relates the results to a graph. | AL6 |
| [Real World Examples of Quadratic Equations](https://www.mathsisfun.com/algebra/quadratic-equation-real-world.html) | Maths is Fun | This excellent resource highlights where quadratic equations are used in the real world and then uses completing the square and the quadratic formula to solve the real-life problems. It also demonstrates how to solve a real-life problem graphically. | AL6 |
| [Quadratic Functions and Parabolas in the Real World](https://www.youtube.com/watch?v=He42k1xRpbQ) | Jennifer Anderson | This short YouTube video demonstrates how quadratics and parabolas are used in the real world. Links to graphs | AL6 |
| [Simultaneous Linear and Quadratic](https://www.mathssite.com/resources/docs/maths/keystage4/gcsemaths/ma2/quadratic/a-simultaneous-linear-and-quadratic.pdf) | Maths Site | This resource offers learners the opportunity to practice their understanding of simultaneous equations to help address some misconceptions. Answers are given to the questions. | AL6 |
| [Simultaneous Equations – Linear / Quadratic](http://www.mathsteacher.com.au/year10/ch13_quadratic_graphs/10_simult_equations/simquad.htm) | Mathsteacher | This concise resource demonstrates how to solve simultaneous equations when one is linear and one is quadratic. Detailed algebraic and graphical solutions are given. | AL6 |
| [Simultaneous Equations (Linear and Quadratic)](https://corbettmaths.com/2013/05/07/simultaneous-equations-linear-and-quadratic/) | Corbettmaths | This excellent video resource demonstrates how to solve simultaneous equations when one equation is linear and the other is a quadratic. | AL6 |
| [Simultaneous Equations – Linear and Non-Linear](http://www.onlinemathlearning.com/simultaneous-linear-quadratic-2.html) | OnlineMaths Learning.com | This resource includes two video clips and demonstrates how to solve simultaneous equations when one is linear and one is quadratic.  | AL6 |
| [Systems of Linear and Quadratic Equations](http://www.phschool.com/atschool/new_york/phmath07_intalg/IANYSENY06.pdf) | Learning Standards for Mathematics | This excellent comprehensive resource demonstrates how to solve simultaneous equations (when one equation is linear and one is quadratic) graphically and algebraically. It includes worked examples and exercises for the learners to attempt. | AL6 |
| [Real World Applications of Polynomial Addition/ Subtraction](https://www.youtube.com/watch?v=8k7TB8bCBaE) | Mathceratops | This video resource demonstrates how real-world problems can be solved by manipulating polynomials.  | AL6 |
| [Modelling a Test Drive](https://www.stem.org.uk/resources/elibrary/resource/31087/modelling-test-drive) | Nuffield Foundation | This resource provides the opportunity for learners to investigate a real-life application of functions and quadratics. Learners will be asked to draw graphs of data generated from a test drive and find linear and quadratic functions to model the data.  | AL6 |
| [Runaway Train](https://www.stem.org.uk/resources/elibrary/resource/31129/runaway-train) | Nuffield Foundation | This activity involves modelling motion as a quadratic function. Students carry out an experiment to collect data about a trolley rolling down a slope. They then use this data to simulate the motion of a train by fitting a quadratic curve to their data, using a graphic calculator or spreadsheet. | AL6 |
| [Corbett’s Conundrums 7th Jan](https://corbettmaths.files.wordpress.com/2014/08/january-7.pdf) | Corbett Maths | Interesting short puzzle that requires a knowledge of indices and leads to a quadratic equation to be solved. | AL6 |
| [Solving Inequalities](http://www.mathcentre.ac.uk/resources/uploaded/mc-ty-inequalities-2009-1.pdf) | Mathscentre | This comprehensive resource introduces learners to solving inequalities. It includes worked examples and exercises for the learners to complete. | AL7 and AL8 |
| [Solving Quadratic Inequalities](https://www.mathsisfun.com/algebra/inequality-quadratic-solving.html) | Maths is Fun | This excellent interactive resource demonstrates how to solve quadratic inequalities. It includes ten questions for the learners to complete with detailed answers. | AL7 and AL8 |
| [Solving Inequalities](http://www.cimt.org.uk/ske/F6/Text.pdf) | CIMT | This comprehensive resource introduces learners to solving inequalities. It includes detailed worked examples and exercises for the learners to complete. | AL7 and AL8 |
| [Solve Inequalities That Contain Fractions](https://www.youtube.com/watch?v=410aoajrAu4) | TenMarks Amazon | This short video demonstrates how to solve linear inequalities that contain fractions. | AL7 and AL8 |
| [Inequalities](https://revisionmaths.com/advanced-level-maths-revision/pure-maths/algebra/inequalities) | Revision Maths | This concise resource demonstrates how to solve linear and quadratic inequalities.  | AL7 and AL8 |
| [Inequalities](https://www.youtube.com/watch?v=jQ2NE4emOgs) | mathstutorbiz | This excellent video resource demonstrates how to solve linear and quadratic inequalities | AL7 and AL8 |
| [How do you Solve A Quadratic Inequality Algebraically?](http://www.virtualnerd.com/algebra-2/quadratics/inequalities/graphing-solving-inequalities/solve-inequality-algebraically) | Virtual Nerd | This short video resource demonstrates how to solve a quadratic inequality algebraically. | AL7 and AL8 |
| [Inequalities in Real Life](https://www.tes.com/teaching-resource/inequalities-in-real-life-6439663) | TES | This resource invites learners to solve a problem using inequalities. | AL7 and AL8 |
| [Solving Real Life Linear Inequalities](https://www.youtube.com/watch?v=rnXcIS-CD7M) | Sarah Messing | This excellent video resource demonstrates how to solve a real life problem using inequalities. | AL7 and AL8 |
| [Fibonacci Surprises](http://nrich.maths.org/11164) | NRICH | This interesting resource invites learners to investigate the Fibonacci sequence. | AL10 |
| [Corbett’s Conundrum 27th Jan](https://corbettmaths.files.wordpress.com/2014/08/january-27.pdf) | Corbett Maths | Investigating iterative sequences. | AL10 |

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