Year 12 Further Mathematics – Complex Numbers

West Kirby Grammar School

Learning about this topic is important because:
Studying complex numbers matters because they unlock entire areas of mathematics and engineering that real numbers alone cannot handle. They let you solve equations with no real solutions, model real-world systems more elegantly, and understand deeper mathematical structures.

This builds on: Quadratics Y12, Roots of equations Y12

This leads to: Argand diagrams Y12FM, Complex numbers Y13FM

We will learn:

- Introduction to imaginary and complex numbers
- Multiply complex numbers
- Divide of complex numbers using the complex conjugate
- Find the roots of quadratic equations
- Solve cubic and quartic equations

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Imaginary, real, complex conjugation, roots, conjugate pair, quadratic, cubic, quartic.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, seeking additional support from your teachers at lunchtime drop-in sessions, searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.

Year 12 Further Mathematics – Complex Numbers

West Kirby Grammar School

Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The work you produce in class (your file), homework, independent study and regular assessment all form the key pieces of work in this topic.

Year 12 Further Mathematics – Argand Diagrams

West Kirby Grammar School

Learning about this topic is important because:
Studying Argand diagrams is important because they turn complex numbers into something you can see. This geometric viewpoint makes abstract algebraic ideas intuitive, reveals structure that is hard to spot from equations alone, and is essential for advanced work in complex analysis and engineering.

This builds on: Vectors Y11/12, Complex numbers Y12FM, Trigonometry Y12, Loci Y11

This leads to: Complex Numbers Y13

We will learn:

- Be able to represent complex numbers on an argand diagram
- Find the modulus and argument of a complex number
- Write any complex number in terms of its modulus and argument
- Use complex numbers to represent a locus of points or regions on an Argand diagram

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Complex numbers, real, imaginary, vector, modulus, absolute value, magnitude, argument, modulus-argument form, loci/locus, shape, circle, perpendicular bisector, half-line, region, inequality, intersection.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, seeking additional support from your teachers at lunchtime drop-in sessions, searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.

Year 12 Further Mathematics – Argand Diagrams

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Year 12 Further Mathematics – Series

West Kirby Grammar School

Learning about this topic is important because:
Studying formulas for the **sum of natural numbers, squares, and cubes** matters because they reveal the hidden structure and patterns inside arithmetic. These formulae form the backbone of algebraic manipulation and appear everywhere from analysing algorithms in computer science to calculating physical quantities in physics and engineering. More importantly, they train you to recognise patterns, generalise them, and prove them.

This builds on: Sequences Y11, Proof Y11/12.

This leads to: Series Y13FM

We will learn:

- Find sums of sets of natural numbers
- Find the sums of squares and cubes of 'n' natural numbers

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Sigma, sum, natural numbers, squares, cubes, quadratic, cubic, quartics.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, Seeking additional support from your teachers at lunchtime drop in sessions, Searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding

Year 12 Further Mathematics – Series

	new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.
Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The work you produce in class (your file), homework, independent study and regular assessment all form the key pieces of work in this topic.	

Year 12 Further Mathematics – Root of Polynomials

West Kirby Grammar School

Learning about this topic is important because:
Studying roots of polynomials is important because roots reveal the fundamental behaviour of a polynomial: where it crosses the axis, how it factors, and how it can be broken into simpler building blocks. Knowing the roots lets you solve equations, analyse functions, understand oscillations and stability in physics and engineering, and work with everything from quadratic curves to high-degree models in data science.

This builds on: Quadratics Y12, Graphs and transformations Y12

This leads to: Complex numbers Y13FM, Differential equations Y13FM

We will learn:

- Derive and use the relationships between the roots of a quadratic equation
- Derive and use the relationships between the roots of a cubic equation
- Derive and use the relationships between the roots of a quartic equation
- Evaluate expressions relating to the roots of polynomials
- Find the equation of a polynomial whose roots are a linear transformation of the roots of a given polynomial

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Quadratic, cubic, quartic, coefficients, Sum of roots, product of roots, real, complex, reciprocals, powers, sums of squares, sums of cubes, linear transformations.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, seeking additional support from your teachers at lunchtime drop-in sessions, searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.

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Year 12 Further Mathematics – Volumes of Revolution

West Kirby Grammar School

Learning about this topic is important because:
Studying volumes of revolution matters because it turns abstract ideas about area, curves, and integration into a powerful method for finding the volume of real 3-D objects, from bowls and bottles to engineering components and physical models. It prepares you for university topics like multivariable calculus, surface integrals, and modelling in physics and engineering, where rotating shapes and continuous volume calculations are everyday tools.

This builds on: Integration Y12

This leads to: Volumes of revolution Y13FM

We will learn:

- Find the volume of revolution when a curve is rotated around the x-axis
- Find the volume of revolution when a curve is rotated around the y-axis
- Find more complicated volumes of revolution
- Model real-life objects using volumes of revolution

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Volume, 3-D, x-axis, y-axis, integration, rotated, radians, cylinder, cone, modelling, limitations.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, Seeking additional support from your teachers at lunchtime drop in sessions, Searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding

Year 12 Further Mathematics – Volumes of Revolution

	new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.
Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The work you produce in class (your file), homework, independent study and regular assessment all form the key pieces of work in this topic.	

Year 12 Further Mathematics – Matrices

West Kirby Grammar School

Learning about this topic is important because:
Learning about matrices matters because they're one of the core languages of modern mathematics and technology: they let you model and solve complex systems efficiently. It also builds powerful algebraic thinking and gives you access to higher-level maths that shows up everywhere in real-world problem-solving.

This builds on: Equations Y11, Simultaneous equations Y11

This leads to: Linear Transformations Y12FM

We will learn:

- Understand the concept of a matrix
- Define the zero and identity matrices
- Add and subtract matrices
- Multiply a matrix by a scalar
- Multiply matrices
- Calculate the determinant of a matrix
- Find the inverse of a matrix
- Use matrices to solve systems of equations
  Interpret simultaneous equations geometrically

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Array, square matrix, zero matrix, identity matrix, product matrix, multiplicatively conformable, determinant, scalar, singular, non-singular, minor, inverse, transpose, consistent, inconsistent, simultaneous, sheaf.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, seeking additional support from your teachers at lunchtime drop-in sessions, searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.

Year 12 Further Mathematics – Matrices

Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The work you produce in class (your file), homework, independent study and regular assessment all form the key pieces of work in this topic.	

Year 12 Further Mathematics – Linear Transformations

West Kirby Grammar School

Learning about this topic is important because:
Learning about linear transformations and matrices matters because they let you model and solve complex systems efficiently, from transforming shapes in computer graphics to analysing networks, encoding data, and understanding linear transformations that underpin physics, engineering, and machine learning.

This builds on: Transformations Y11, Matrices Y12FM,

This leads to: Computer graphics, Mechanics or Engineering in Further Education

We will learn:

- Understand the properties of linear transformations and represent them using matrices
- Perform reflections and rotations using matrices
- Carry out enlargements and stretches using matrices
- Find the coordinates of invariant points and the equations of invariant lines
- Carry out successive transformations using matrix products
- Understand linear transformations in three dimensions
- Use inverse matrices to reverse linear transformations

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Matrix, image, linear, reflections, rotations, invariant, enlargement, stretch, geometrically, scale factor, inverse.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, seeking additional support from your teachers at lunchtime drop-in sessions, searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.

Year 12 Further Mathematics – Linear Transformations

Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The work you produce in class (your file), homework, independent study and regular assessment all form the key pieces of work in this topic.	

Year 12 Further Mathematics – Proof by Induction

West Kirby Grammar School

Learning about this topic is important because:
Proof by induction is important because it gives you a rigorous, systematic way to establish that a statement is true for **every** natural number, something ordinary algebra can't reliably do. It trains you to think recursively, to spot patterns, and to understand how complex structures can be built from simple beginnings.

This builds on: Proof Y11/12, Series Y12FM

This leads to: Proof Y13

We will learn:

- Understand the principle of proof by mathematical induction and prove results about sums of series
- Prove results about divisibility using induction
  Prove results about matrices using induction

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Proof, for all, basis, assumption, inductive, conclusion, sum of, integers, natural numbers, divisible, matrices.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, seeking additional support from your teachers at lunchtime drop-in sessions, searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.

Year 12 Further Mathematics – Proof by Induction

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Year 12 Further Mathematics – Vectors

West Kirby Grammar School

Learning about this topic is important because:
Studying the vector equations is important because these tools let you describe geometry in three dimensions with precision and power, turning spatial problems into clean algebra that you can actually compute with. They're the foundation for understanding angles, distances, intersections, and motion in space—ideas that show up in physics, engineering, computer graphics, navigation, and any field that models the real world mathematically.

This builds on: Straight line graphs Y12, Vectors Y12, Trigonometry Y11

This leads to: Geometry, Calculus or Linear Algebra in Further Education

We will learn:

- Understand and use the vector and Cartesian forms of the equation of a straight line in three dimensions
- Understand and use the vector and Cartesian forms of the equation of a plane
- Calculate the scalar product for two 3D vectors
- Calculate the angle between two vectors, two lines, a line and a plane, or two planes
- Understand and use the scalar product form of the equation of a plane
- Determine whether two lines meet and determine the point of intersection
  Calculate the perpendicular distance between: two lines, a point and a line, or a point and a plane

We will develop/practise skills including:

- Use and apply standard techniques: Select and correctly carry out routine procedures; and accurately recalling facts, terminology and definitions.
- Reason, interpret and communicate mathematically: Construct rigorous mathematical arguments, make deductions and inferences, assess the validity of mathematical arguments, explaining your reasoning; and using mathematical language and notation correctly.
- Solve problems within mathematics and in other contexts: Translate problems in mathematical and non-mathematical contexts into mathematical processes, use mathematical models and interpret solutions to problems in their original context, and, where appropriate, evaluating their accuracy and limitations and explain how to refine them.

Some of the vocabulary that we will use includes:
Position vector, scalar, direction vector, arbitrary point, parallel, non-parallel, perpendicular, parameter, plane, normal vector, scalar product, dot product, intersecting, skew, unit vector.

You could learn more about this topic by:
Completing all exercises, mixed exercises, challenges and review questions from the textbook, seeking additional support from your teachers at lunchtime drop-in sessions, searching online for the topic and GeoGebra to find relevant visual and interactive tools for understanding

Year 12 Further Mathematics – Vectors

	new concepts, using free question banks and revision tools on websites such as MathsGenie and Physics Maths Tutor.
Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The work you produce in class (your file), homework, independent study and regular assessment all form the key pieces of work in this topic.	