Subject	Y12 Core Knowledge – Autumn/Spring/Summer term	How to support students' learning
Maths – Further Maths	**Autumn Term** **Pure -** 1. Solve quadratic equations with complex roots. 2. Add, subtract and multiply and divide complex numbers. 3. Solve problems involving complex numbers by equating real and imaginary parts. 4. Represent a complex number on an Argand diagram. 5. Add and subtract matrices of the same order. 6. Multiply a matrix by a scalar. 7. Know that matrix multiplication is associative but not commutative. 8. Find the matrix associated with a linear transformation in two dimensions (including reflections, rotations, enlargements, stretches, shears). 9. Find the matrix associated with a linear transformation in three dimensions. 10. Understand successive transformations in two dimensions. 11. Find invariant points. 12. Find invariant lines. 13. Know the relationship between the roots and coefficients of quadratic, cubic and quartic equations. 14. Form new equations whose roots are related to the roots of a given equation. 15. Solve polynomial equations with complex roots. 16. Use proof by induction to prove the given results for the sum of a series. 17. Use proof by induction to prove the given results for the nth term of a sequence. 18. Use proof by induction to prove the given results for the nth power of a matrix. 19. Find the determinant of a 2x2 matrix. 20. Understand that the determinant of a 2x2 matrix represents the area scale factor of the corresponding transformation. 21. Know that the determinant of a 3x3 matrix represents the volume scale factor of the corresponding transformation. 22. Understand the significance of a zero determinant. 23. Know what is meant by a singular matrix. 24. Find the inverse of a non-singular 2x2 matrix.	• If students need support with their learning, almost everything they need can be found on Integral Maths. They have a unique login for this and are regularly set homework tasks. There is a wealth of videos and resources which they can use to independently recap any topics in which they've struggled. • For past exam papers; https://www.physicsandmathstutor.com and www.mathsgenie.co.uk offers a range of past papers, mark schemes and model answers. If students need support or guidance with any of this, their class teacher can direct them to the appropriate content.

	25. Use a calculator to find the determinant and inverse of a 3x3 matrix. 26. Use the product rule for inverse matrices. 27. Use matrices to solve a pair of linear simultaneous equations in two unknowns. 28. Use matrices to solve three linear simultaneous equations in three unknowns. 29. Know and use the conversion between degrees and radians. 30. Know the double angle/addition formulae. **Spring/Summer Term** **Pure -** 31. Find the modulus of a complex number. 32. Find the principal argument of a complex number using radians. 33. Express a complex number in modulus-argument form. 34. Multiply and divide complex numbers in modulus-argument form. 35. Represent multiplication and division of two complex numbers on an Argand diagram. 36. Represent and interpret sets of complex numbers as loci on an Argand diagram: lines of the form $\|z-a\| = \|z-b\|$, half-lines of the form $\arg(z-a) = \theta$, circles of the form $\|z-a\| = r$. 37. Represent and interpret regions defined by inequalities based on the above. **Mechanics -** 38. Draw and interpret position–time, distance–time, velocity–time, speed–time and acceleration–time graphs and how to use these to solve problems connected with motion in a straight line. 39. Find average speed and average velocity. 40. Use the constant acceleration formulae to solve problems involving linear motion. 41. Solve with problems involving motion under gravity. 42. Use calculus to derive expressions for position, velocity and acceleration as functions of time. 43. Solve problems involving linear motion with variable acceleration. 44. Draw a diagram showing the forces acting on a body. 45. Apply Newton's laws of motion to problems in one or more dimensions. 46. Resolve a force into components having selected suitable directions for resolution.	

	47. Find the resultant of several concurrent forces. 48. Solve problems involving forces in equilibrium. 49. Formulate the equation of motion of a particle which is being acted on by several forces. 50. Model friction using $F = \mu R$. 51. Derive and use the result that a body on a rough slope inclined at angle α to the horizontal is on the point of slipping if $\mu = \tan \alpha$. 52. Calculate the moment about a fixed-point O of a force acting on a body as the product of the force and the perpendicular distance of O from the line of action of the force. 53. Know that an object is in equilibrium if the resultant of all the applied forces acting on it is zero and the sum of their moments about any point is also zero. 54. Calculate the moment about a fixed-point O of a force acting on a body by resolving the force into components. 55. Calculate the work done by a force which moves along its line of action. 56. Use the principle of conservation of energy. 57. Use the work–energy principle. 58. Calculate kinetic energy. 59. Calculate gravitational potential energy. 60. Calculate the work done by a force which moves at an angle to its line of action. 61. Understand and use the concept of power. 62. Find the loss of kinetic energy during a direct impact. 63. Apply the principle of conservation of momentum to direct impacts. 64. Understand Newton's law of impact and know the meaning of coefficient of restitution. 65. Find the dimensions of a quantity in terms of M, L and T. 66. Change the units in which a quantity is given. 67. Use dimensional analysis to determine unknown indices in a proposed formula or check a relationship for consistency. 68. Identify the forces acting on a body in circular motion. 69. Calculate acceleration towards the centre of circular motion. 70. Model situations involving circular motion with uniform speed in a horizontal plane.	

	Additional Pure - 71. Work with general sequences given as recurrence relations or by position-to-term (closed form) formulae. 72. Use induction to prove results relating to both sequences and series. 73. Describe various possibilities for the behaviour of sequences. 74. Use the limit of the nth term of a sequence as n tends to infinity, including steady states. 75. Work with the Fibonacci numbers (and other Fibonacci-like sequences, such as the Lucas numbers), and understand their properties. 76. Solve a first-order linear recurrence relation with constant coefficients, using the associated auxiliary equation and complementary function. 77. Apply their knowledge of recurrence relations to modelling. 78. Work with numbers written in base n, where n is a positive integer. 79. Use (without proof) standard tests for divisibility by 2, 3, 4, 5, 8, 9 and 11. 80. Establish suitable (algorithmic) tests for divisibility by other primes less than 50. 81. Use the division algorithm. 82. Use finite arithmetic's. 83. Solve single linear congruences. 84. Understand the concepts of prime numbers, composite numbers, highest common factors (hcf), and coprimality (relative primeness). 85. Know and use Euclid's lemma. 86. Work with binary operations and their properties when defined on given sets. 87. Construct Cayley tables for given finite sets under the action of a given binary operation. 88. Use the definition of a group, for example to show that a given structure is, or is not, a group. 89. Use the Latin square property for group tables. 90. Determine the orders of elements in a given group. 91. Use the definition of a subgroup, find subgroups and show that given subsets are, or are not, proper subgroups. 92. Understand that a cyclic group is generated by "powers" of a single element.	

	93. Be familiar with the structure of finite groups up to, and including, order seven, and apply this knowledge in solving problems. 94. Use the definition, in geometrical terms, of the vector product and form the vector product in magnitude and direction, and in component form. 95. Understand the anti-commutative and distributive properties of the vector product. 96. Use the vector product to calculate areas of triangles and parallelograms. 97. Understand the significance of a x b = 0. 98. Work with functions of two variables, given either explicitly in the form z = f (x, y) or implicitly in the form g (x, y, z) = c. 99. Sketch sections and contours and know how these are related to the surface. 100. Find first and second derivatives, including mixed derivatives. 101. Work with stationary points and know they can be maxima, minima or saddle-points.	