ALGEBRA SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 1. Algebraic manipulation (2 hours)	Simplifying algebraic fractions	AL2: Simplify expressions involving algebraic fractions.	GCSE Maths	First remind students of the principles involved when adding, subtracting, multiplying, dividing and simplifying fractions. Discuss why $\frac{6+8}{10}$ is the same as $\frac{3+4}{5}$ but $\frac{6\times8}{10}$ is not the same as $\frac{3\times4}{5}$	Algebraic fractions1	Algebraic Fractions 1 - Simplifying, Adding & Subtracting
	Simplifying expressions containing square roots	AL2: Simplify expressions involving square roots.	GCSE Maths	Use $\sqrt{3^2+4^2} \neq 3+4$ to demonstrate that $\sqrt{a^2+b^2}$ does not simplify to $a+b$. Use $\sqrt{3}\times\sqrt{3}=3$ to explain that $\sqrt{x}\times\sqrt{x}=x$ Explain that the square root sign gives the positive root only, e.g. $\sqrt{4}=2$, but not -2. However, the solution to $x^2=4$ is $x=\pm2$	Expressions involving square roots	Lesson Element Using and manipulating Surds Relevance of Surds The Root of the Problem Surds inquiry Surd activities

ALGEBRA SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 2. Polynomials, functions and equations (3 hours)	Addition and subtraction of polynomials	AL3: Add and subtract polynomials.	GCSE Maths	Dealing with negative terms can often lead to errors. Students should feel comfortable rearranging polynomials, e.g. $2x^3 - 5x^2 + 4x - 7$ is the same as $4x - 5x^2 - 7 + 2x^3$	Polynomial activities	Polynomials
	Multiplication of polynomials	AL3: Multiply polynomials.	GCSE Maths	Encourage students to adopt a systematic approach, otherwise terms may be omitted or duplicated.		
	Division of polynomials	AL3: Divide polynomials.	GCSE Maths	When using long division, students should be encouraged to set their work out in columns. The most able students should be encouraged to divide by inspection.	Operations with polynomials	Polynomial Division & Equating Coefficients How to divide polynomials using long division
	The factor theorem	AL4: Find linear factors of a polynomial.	AL3	If a function has not been defined in a question, then students should be discouraged from using function notation without first defining their function, e.g. Let $f(x) = \ldots\ldots$	The factor theorem	The Factor Theorem
	Completing the square	AL5: Complete the square of a quadratic polynomial.	GCSE Maths	Students should be able to deal with expressions with a coefficient of x^2 other than 1. The most able students will appreciate that c is the greatest (or least) value of an expression of the form $a(x+b)^2 + c$	Geogebra activity Completing the square activity	Completing the Square

ALGEBRA SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 3. Applications of equations and inequalities in one variable (4 hours)	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.	GCSE Maths	Students should appreciate that division by zero is not possible. For example, when solving quadratic equations such as $x^2 + 3x = 0$ a common error is to divide both sides of the equation by x, and consequently lose a root.	Simultaneous equations Quadratic activities	Modelling a Test Drive Runaway Train
	Inequalities	AL7: Manipulate inequalities. AL8: Set up and solve linear and quadratic inequalities algebraically and graphically.	GCSE Maths	Students should be discouraged from replacing an inequality sign with an equals sign. A common error when solving inequalities is to fail to reverse the sign when multiplying or dividing by a negative value. Students should understand why the solution to $x(x-3) > 0$ can be written as $x < 0$ or $x > 3$ but not $x < 0$ and $x > 3$	Linear & quadratic inequalities Inequality activities	Inequalities in Real Life How do you Solve A Quadratic Inequality Algebraically? Solving Quadratic Inequalities

ALGEBRA SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 4. Sequences and recurrence relationships (1 hour)	Sequences and recurrence relationships	AL10: Understand and use notation of recurrence relationships to describe and determine sequences. AL11: Use recurrence relationships in modelling.	GCSE Maths	Students often fail to realise that a sequence such as $u_{n+1} = 3u_n - 2$ could also be written as $u_m = 3u_{m-1} - 2$	Sequences and recurrence relationships Sequence activities	Fibonacci Surprises

COORDINATE GEOMETRY SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 5. Points, lines and circles (2 hours)	The line joining two points	CG1: Calculate the distance between two points. CG2: Find the mid-point of a line segment.	GCSE Maths	Problems can sometimes occur when dealing with negative coordinates. Some students may benefit from first practising the addition and subtraction of directed numbers.	Geogebra: distance Geogebra: midpoint Geogebra: Distance1 Geogebra: Midpoint	Distance2
	The coordinate geometry of circles	CG3: Know and use the equation of a circle $(x-a)^2+(y-b)^2=r^2$ where (a,b) is the centre and r is the radius of the circle.	AL5	Students should practise converting between the two formats: $(x-a)^2+(y-b)^2=r^2$ and $x^2+y^2+fx+gy+h=0$ Remembering the circle theorems learned at GCSE may help when solving circle problems.	Equation of a circle	Circles2
Chapter 6. Graphs (2 hours)	Linear and polynomial functions	CG4: Sketch and plot linear and polynomial functions.	GCSE Maths	Students are often uncomfortable when first asked to sketch a graph rather than plot, as it requires a deeper understanding. Students must learn the shapes of standard graphs and remember to include the axis intercepts. A polynomial of order n has up to $n-1$ turning points.	Graphing polynomial functions	Cubic
	Trigonometric and exponential functions	CG4: Sketch and plot trigonometric and exponential functions.	GCSE Maths		Geogebra: Exponential graphs Walkthrough: Trig graphs	Exponential

COORDINATE GEOMETRY SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 7. Linear inequalities in two variables (3 hours)	Illustrating linear inequalities in two variables	AL9: Illustrate linear inequalities in two variables.	AL7 & AL8	Students should be encouraged to use a ruler when sketching straight line graphs and when drawing axes.	Inequalities in 2D	Desmos graphing
	Using inequalities for problem solving	CG6: Express real situations in terms of linear inequalities.	AL9	When shading, students should be careful not to hide crucial numbers and lines. When setting up an inequality related to a real situation it can be useful to substitute numbers to check that the inequality sign is correctly oriented. It can be useful to label each line with its equation.	Linear programming1	Region
	Linear programming	CG7: Use graphs of linear inequalities to solve 2-dimensional maximisation and minimisation problems. CG8: Know the definition of objective function and be able to find it in 2-dimensional cases.	CG6			

TRIGONOMETRY SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 8. Trigonometric functions (4 hours)	Trigonometric functions for angles of any size	PT1: Use the definitions of $\sin\theta$, $\cos\theta$ and $\tan\theta$ for any angle and their graphs.	GCSE Maths	Students should first check that their calculators are in 'degrees' mode.	Trig functions1 Trig functions2	Trigonometry
	The sine and cosine rules and proof	PT2: Know the sine and cosine rules and be able to apply them, including the ambiguous case for sine.	PT1	An accurate construction can often help students who struggle to understand why two possible triangles are sometimes possible when finding an angle from the sine rule.	Geogebra: Sin & cos rules1	
	Identities involving $\sin\theta$, $\cos\theta$ and $\tan\theta$	PT3: Know and use the identity $\tan\theta \equiv \frac{\sin\theta}{\cos\theta}$ PT4: Know and use the identity $\sin^2\theta + \cos^2\theta \equiv 1$	PT1	Students should understand the difference between $\sin^2 x$, $\sin x^2$, $\sin^{-1} x$, $(\sin x)^{-1}$ Use Pythagoras' theorem to demonstrate the identity $\sin^2\theta + \cos^2\theta = 1$	Trig identities1	
	Using trigonometrical identities to solve equations	PT5: Solve simple trigonometric equations in given intervals.	PT3 & PT4	Using knowledge of the shape of the graphs is the best way to work with the sin, cos and tan of any angle. When solving equations of the form $\sin 2x = \alpha$ a common error is to divide $\sin^{-1}\alpha$ by 2 before finding the other angles.	Geogebra: Trig equations1	
Chapter 9. Applications of trigonometry (2 hours)	Applications in modelling	PT6: Apply Pythagoras' Theorem and trigonometry to 2- and 3-dimensional problems.	PT2	A sketch is useful when solving 2-D problems.		
	Working in three dimensions			Students should be encouraged to draw each triangle as they solve it. If necessary, students could sketch each triangle in order to decide which one(s) to use.		

SELECTIONS SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 10. Permutations and combinations (3 hours)	Probability diagrams	EN2: Construct and use tree diagrams, two-way tables, Venn Diagrams to enumerate outcomes. EN6: Solve problems about outcomes, including problems in the context of probability.	GCSE Maths	Students often forget that $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B)$ can only be used if A and B are independent, and that $\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B)$ can only be used if A and B are mutually exclusive.	Products, tree & Venn diagrams	Sets and Venn diagrams
	Factorials and the product rule	EN3: Use the product rule for counting numbers of outcomes of combined events. EN6: Solve problems about outcomes, including problems in the context of probability.	GCSE Maths	When solving such problems, it is sometimes easier to first solve a similar problem with smaller numbers. Then, if necessary, all outcomes can be listed.		Product rule
	Permutations and combinations	EN4: Enumerate the number of ways of obtaining an ordered linear subset (permutation) of r elements from a set of n distinct objects. EN5: Enumerate the number of ways of obtaining an unordered subset (combination) of r elements from a set of n distinct objects. EN6: Solve problems about outcomes, including problems in the context of probability.	EN3	${}_n\mathrm{C}_r$ and ${}_n\mathrm{P}_r$ are sometimes confused. The number of arrangements when the order is considered $\left({}_n\mathrm{P}_r\right)$ will be greater than when the order is not considered $\left({}_n\mathrm{C}_r\right)$.	Perms & Combs1	Ways to choose

SELECTIONS SECTION Chapter 11. The binomial distribution (2 hours)	Binomial expansion	EN1: Understand and be able to apply the binomial expansion of $(a+b)^n$ where n is a positive integer.	GCSE Maths	Mistakes often occur when students simplify their expansion prematurely.	The binomial expansion	Binomial expansion2
	The binomial distribution	EN2: Use the binomial distribution to enumerate outcomes. EN6: Solve problems about outcomes, including problems in the context of probability.	EN1 & EN5	Students find a binomial distribution easier to use when they define their variable clearly before attempting to answer the question.	The binomial distribution	Binomial distribution2

POWERS and ITERATION SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 12. Exponentials and logarithms (4 hours)	Properties of the exponential function	EL1: Know and use the function ka^x and its graph, where a is positive.	GCSE Maths	When sketching the exponential graph, students will find it easier to start near the asymptote and draw away from it.	Geogebra: Exponential graphs	Exponentials and logarithms
	Logarithms	EL2: Know and use the definition of $\log_a x$ as the inverse of a^x. EL3: Understand and use the laws of logarithms.	EL1	Old logarithm books could be used to demonstrate how base ten was used to carry out difficult calculations before the advent of the calculator. The anti-log pages at the back could be used to illustrate the link with the exponential.	Exponentials & logs Logs intro Log laws	
	Reduction to linear form	EL4: Convert equations of the form $y = ka^x$ and $y = kx^n$ to a linear form using logarithms. EL5: Estimate values of k and a (or k and n) from graphs.	EL1-3	Students could be encouraged to discuss ways to improve the reliability of their estimates. This could then lead to a discussion on the accuracy of the estimates produced.		
	Equations involving exponentials	EL6: Solve equations of the form $a^x = b$ for $a > 0$. EL7: Use exponentials and logarithms in problems involving exponential growth and decay.	EL1-3	Students could explore the use of different bases to solve such equations.		

POWERS and ITERATION SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 13. Numerical methods (7 hours)	Locating a root of an equation	NM1: Solve equations approximately by considering the change of sign. NM3: Recognise when these numerical methods may fail.	EL2	The use of graph plotting software will provide students with opportunities to experiment and to predict when a change of sign may fail.	Solution of equations1	Interval bisection
	Improving a root					
	Iterative sequences	NM2: Use a simple iterative method to solve equations approximately. NM3: Recognise when these numerical methods may fail.	EL2	Scientific calculators allow students to experiment with a variety of sequences for one equation, varying the start point for each sequence. A spreadsheet will help when dealing with a sequence which converges too slowly.		Numerical methods
	Gradients of tangents	NM4: Use a chord to estimate gradient of a tangent to a curve at a point. NM5: Recognise how to improve an estimate for the gradient of a curve at a point.	EL2	The use of graph plotting software will help to illustrate how a gradient estimate can be improved, and why moving closer to a point can sometimes produce a worse estimate.	Approximating gradients	Introducing calculus
	Area from rectangles	NM6: Use rectangular strips to estimate the area between a curve and the x-axis. NM8: Recognise whether an estimate would be an over- or underestimate, and understand how to calculate an improved estimate.	EL2	Students should be encouraged to write their coordinates in a table to avoid confusion. The use of graph plotting software will help to illustrate how an estimate could be an underestimate or an overestimate. It could also be used to demonstrate how an estimate could be improved.		

POWERS and ITERATION SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 13. Numerical methods (continued)	Area under a curve	NM7: Use the trapezium rule to estimate the area between a curve and the x-axis. NM8: Recognise whether an estimate would be an over or under estimate, and understand how to calculate an improved estimate.	EL2	Students should be encouraged to write their coordinates in a table to avoid confusion. The use of graph plotting software will help to illustrate how an estimate could be an underestimate or an overestimate. It could also be used to demonstrate how an estimate could be improved.	Approximating area	Introducing calculus
	Applications of numerical methods	NM9: Apply numerical methods in context where appropriate.	NM4-8	Students should be encouraged to check the consistency of units.		

CALCULUS SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 14. Differentiation (4 hours)	Differentiation	CA1: Differentiate kx^n where n is a positive integer or 0, and the sum of such functions.	NM4	Students should understand that $\frac{d}{dx}$ is the operator, and that y is the operand, when $\frac{dy}{dx}$ is written.	Gradient of a curve Tangents, normal & stationary points	Introducing calculus
	The gradient of a curve	CA2: Know that the gradient function gives the gradient of the curve and measures the rate of change of y with x. CA3: Know that the gradient of the function is the gradient of the tangent at that point. CA4: Find the equation of a tangent and normal at any point on a curve.	CA1	Students may find it useful to remember that a constant term added to a function simply translates its graph vertically and has no effect on its gradient. Hence a constant term differentiates to zero. A diagram can often be helpful when solving problems related to tangents and/or normal to curves.		
	Stationary points	CA5: Use differentiation to find stationary points on a curve.	CA2	The use of graph plotting software would help students to gain a better understanding of stationary points.		
	Extension - the second derivative	CA6: Determine the nature of a stationary point. CA7: Sketch a curve with known stationary points.	CA5	Students should understand that a maximum or minimum is 'local' and is not necessarily a greatest or least value of the function.		

CALCULUS SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 15. Integration (5 hours)	The rule for integrating x^n where n is a positive integer	CA8: Integrate kx^n where n is a positive integer or 0, and the sum of such functions. CA9: Be aware that integration is the reverse of differentiation.	CA1	Graph plotting software could be used to illustrate the family of curves produced when a polynomial is integrated.	Reversing differentiation	Introducing calculus
	Definite integrals	CA10: Know what is meant by an indefinite and a definite integral. CA11: Evaluate definite integrals.	CA8	It is useful for students to see why a constant is not required when evaluating a definite integral.		
	Areas between a curve and the x-axis Areas below the x-axis	CA12: Find the area between a curve, two ordinates and the x-axis.	CA11	Students could use this to compare with estimates calculated using the trapezium rule and/or rectangles.	Finding areas	
	The area between two curves	CA13: Find the area between two curves.	CA12	Students may find it useful to see why this technique works when parts of the required area are below the x-axis. This is easily demonstrated by translating both graphs vertically upwards.		

CALCULUS SECTION	Topic	Learning Outcomes	Precedences	Teaching points	Integral resources	Free resources
Chapter 16. Application to kinematics (3 hours)	Motion in a straight line	CA15: Recognise the special case where the use of constant acceleration formulae is appropriate.	GCSE Maths	Before using a suvat formula, students should: • check that the acceleration is constant; • check that the units are consistent; • decide on a start position and a finish position; • choose a positive direction.	suvat1	suvat3
	Acceleration due to gravity Finding displacement from velocity and velocity from acceleration	CA14: Use differentiation and integration with respect to time to solve simple problems involving variable acceleration.	CA1 & CA8	It is useful for students to see $s = ut + \frac{1}{2}at^2$ differentiated to produce $v = u + at$	Variable acceleration1	Variable acceleration3