	Pure	Applied
	Algebraic Expressions	**Modelling in Mechanics - Definitions**
Objectives	The laws of indices Negative and fractional indices Polynomials, expanding brackets and collecting like terms Factorising, including cubic expressions of the type $ax^3 + bx^2 + cx$ Surds Surds: Rationalising the denominator	Understand and use fundamental quantities and units in the SI system: length, time, mass Understand and use derived quantities and units: velocity, acceleration, force, weight. Know the difference between position, displacement and distance; Know the difference between velocity and speed and between acceleration and magnitude of acceleration Know the difference between mass and weight (including gravity) Understand there are different types of forces. Understand the concept of a mathematical model
Misconceptions	Students often leave surds un-simplified especially when rationalising a denominator using the complex conjugate. Common errors include: misinterpreting $(a\sqrt{b})^2$ as $(a+\sqrt{b})^2$; evaluating $(\sqrt{2})^2$ as 4 instead of 2; slips when multiplying out brackets; basic arithmetic errors; and leaving surds in the denominator rather than fully simplifying fractions. Two examples of errors with indices are, writing $\frac{1}{3x}$ as 3x–1and writing $\frac{4}{\sqrt{x}}$ as $4x^{\frac{1}{2}}$; these have significant implications later in the course (e.g. differentiation). Many of these errors can be avoided if students carefully check their work and have plenty of practice. Students often struggle to evaluate indices involving both a fractional and negative power. This is especially true when the base involves an algebraic and numerical term.	Students may mix up mass and weight and their related units. Some struggle to use the correct vocabulary e.g. for velocity and displacement. It is important to be really clear when giving the definitions and to always use the correct vocabulary in discussions. Students can generally correctly state assumptions, but they need to make sure that any assumptions or statements about the model relate directly to the context they are considering. For example, they could make the comment 'the resistance will not be constant' more specific by saying 'resistance will increase as velocity increases'.
Key Words Tier 2	Add, subtract, multiply, divide, fraction, simplify.	Assumptions, modelling, smooth, rough, light, direction, reaction, tension, plane.
Key Words Tier 3	Expression, function, constant, variable, term, unknown, coefficient, index, linear, substitution, factorise, power, exponent, base, rational, irrational, reciprocal, root, standard form, surd, rationalise, exact, manipulate, quadratic, quotient, intercepts.	Inelastic, inextensible, particle, rigid body, mass, weight, rod, lamina, length, distance (m), displacement (m), velocity (m s^{-1}), speed (m s^{-1}), acceleration (m s^{-2}), force (N), retardation (m s^{-2}), newtons (N), scalar, vector, direction, magnitude, (normal), friction, thrust, compression
Homework	Book 1 Mixed exercise Unit 1 Mathsgenie website: Algebraic Expressions	Book 1 Mixed exercise Unit 8
Assessment	Algebraic expressions unit assessment	**Quantities and Units in Mechanics**
Career links	Actuarial Science, Biochemistry	Mechanical engineering
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Quadratics	**Kinematics 1 (Constant acceleration)**
Objectives	Solving quadratic equations by factorising, completing the square and the formula. (must be able to derive the formula.) Quadratic functions and their graphs. The roots of a function, as well as their domain and range The use of the discriminant Modelling with quadratics: The use of quadratic functions to model real – life situations	Understand and use the language of kinematics: position; displacement; distance travelled; velocity; speed; acceleration. Understand, use and interpret graphs in kinematics for motion in a straight line: displacement against time and interpretation of gradient; velocity against time and interpretation of gradient and area under the graph. Be able to draw and interpret kinematics graphs, knowing the significance (where appropriate) of their gradients and the areas underneath them. Understand, use and derive formulae for constant acceleration for motion in a straight line (SUVAT equations). Recognise when it is appropriate to use the suvat formulae for constant acceleration. Be able to solve kinematics problems using constant acceleration formulae. Be able to solve problems involving vertical motion under gravity. Understand and use weight and motion in a straight line under gravity; gravitational acceleration, g, and its value in S.I. units to varying degrees of accuracy.
Misconceptions	Students often struggle manipulating quadratics when the x^2 term is negative. Some students are unclear on the conditions for the number of roots when finding the discriminant. Students often resort to using the formula when solving quadratics when it is more appropriate and efficient to use completing the square. When sketching quadratic functions with no real roots students often make mistakes by drawing the curve below y = 0.	Many students can draw a velocity time graph with the correct shape, but do not always label the required speeds and times clearly on the axes. Students often tend to add a scale (for example 4, 8, 12, 16, …) unnecessarily, rather than just indicating the initial and final speeds. Candidates are able to find distance travelled and the acceleration from velocity–time graphs and can find an average speed, but some struggle with the vocabulary of velocity and displacement. Students are generally able to use suvat formulae in 2D to find unknown heights, velocities etc. However, students sometimes ignore the significance of a negative value for velocity, acceleration or displacement

		and don't refer their answer back to the original problem. They need to recognise that s = –3 m means the object is 3 m below its starting point in the negative direction i.e. s is effectively a coordinate. This is where a diagram helps students understand the physics of the situation.
Key Words Tier 2	Modelling, solve, complete, derive, turning point, formula, draw, sketch.	Graph, average, represent, model, derive.
Key Words Tier 3	Expression, function, constant, variable, term, unknown, coefficient, index, linear, identity, simultaneous, elimination, substitution, factorise, completing the square, intersection, change the subject, cross-multiply, power, exponent, base, rational, irrational, reciprocal, root, standard form, surd, rationalise, exact, manipulate, sketch, plot, quadratic, maximum, minimum, turning point, transformation, translation, discriminant, real roots, repeated roots, intercepts, inequality.	Distance (m), displacement (m), speed (m s^{-1}), velocity (m s^{-1}), acceleration (m s^{-2}), retardation (m s^{-2}), deceleration (m s^{-2}), scalar, vector, 2D, linear, area, trapezium, gradient, equations of motion, gravity, constant, 9.8 m s^{-2}, vertical.
Homework	Book 1 Unit 2 Mixed exercise Mathsgenie website: Completing the Square, The Discriminant	Book 1 Mixed exercise Unit 9 Mathsgenie website: SUVAT, Velocity Time Graphs, Variable Acceleration
Assessment	Quadratics unit assessment	**Kinematics 1 (constant acceleration)**
Careers links	Aeronautical Engineering, Biomedical Sciences	AI Development Analyst
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Equations and Inequalities	**Data Collection – Statistical sampling**
Objectives	Solving linear simultaneous equations Solving quadratic simultaneous equations Solving simultaneous equations on graph Solving linear inequalities. Solving quadratic inequalities Representing inequalities on graphs (the use of dotted and solid lines required on graphs)	Introduction to sampling terminology: Understand and be able to use the terms 'population' and 'sample'. Know how to use samples to make informal inferences about the population. Be able to describe the advantages and disadvantages of sampling compared to census. Understand and be able to use sampling techniques: Able to select or critique sampling techniques in the context of solving a statistical problem. Understand that different samples can lead to different conclusions about the population. Understand and be able to identify different types of data. Know and be able to use the large data set.
Misconceptions	Students often forget to change the inequality sign when multiplying or dividing by a negative. Students can get confused with the set notation for solving quadratic inequalities. Encourage them to sketch a graph and marked on the desired range of values. For instance, $x^2 - 7x + 12 < 0$ can have the incorrect solution of $x < 3$ and $x > 4$ rather than $3 < x < 4$. When solving simultaneous equations students often forget to find both the x and y solutions after finding one.	Some students confuse sample sizes and population sizes, but the recurring problem is not giving answers in context. Candidates need to be clear about the difference between sample sizes and population sizes. Students need to be able to describe the sampling techniques clearly and will lose marks if they are not sufficiently precise. As always, answers must be given using the context of the question and not simply be quoted from text books in a general form.
Key Words Tier 2	Equation, equality, inequality, solve, linear, represent, turning point, below, above, rearrange, corresponding, sketch, coordinate, region.	Population, census, sample.
Key Words Tier 3	Expression, function, constant, variable, term, unknown, coefficient, index, linear, identity, simultaneous, elimination, substitution, factorise, completing the square, intersection, change the subject, cross-multiply, power, exponent, base, rational, irrational, reciprocal, root, standard form, surd, rationalise, exact, manipulate, sketch, plot, quadratic, maximum, minimum, turning point, transformation, translation, polynomial, discriminant, real roots, repeated roots, factor theorem, quotient, intercepts, inequality, asymptote .	Sampling unit, sampling frame, simple random sampling, stratified, systematic, quota, opportunity (convenience) sampling.
Homework	Book 1 Unit 3 Mixed exercise Mathsgenie website: Quadratics Inequalities and Simultaneous Equations	Book 1 Mixed exercise Unit 9 Mathsgenie website: Sampling
Assessment		**Statistical Sampling**
Career links	Chemical Engineering, Dentistry	Astronomer
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management

	Graphs and Transformations	Measures of Location and Spread
Objectives	Sketch the graphs of simple functions, including: • cubic graphs • quartic graphs • and reciprocal graphs $y = \frac{k}{x}$ Geometrical interpretation of algebraic solution of equations. Use of intersection points of graphs of functions to solve equations. Translating graphs: The effects of simple transformations on the graph of y = f(x) as represented by y = f(x)+k and y = f(x+k) Stretching graphs: The effects of simple transformations on the graph of y = f(x) as represented by y = kf(x) and y = f(kx) Reflecting graphs: The effects of simple transformations on the graph of y = f(x) as represented by y = -f(x) and y = f(-x) Transforming graphs.	Calculation and interpretation of measures of location: - be able to calculate measures of location, mean, median and mode, as well as quartiles and percentiles - be able to calculate measures of variation, standard deviation, variance, range and interpercentile range using linear interpolation; percentiles from grouped data using linear interpolation -be able to calculate standard deviation from summary statistics - be able to interpret and draw inferences from summary statistics - data may be discrete, continuous, grouped or ungrouped Coding for both mean and standard deviation - must be able to uncode both mean and standard deviation
Misconceptions	Students are often confused about the number of roots a polynomial has when they involve repeated roots. When plotting cubic and quartic graphs, students often confuse the direction of curves. Students lose examination marks by not labelling all the key coordinates where the curve passes through the axes.	When calculating the mean, of grouped data some student may divide by the number of groups rather than the number of items of data, they may also use class widths in the calculation rather than the mid-points. When finding the standard deviation, the most common error is forgetting to take the square root (perhaps because they are not clear about the difference between variance and standard deviation). Some students waste time by ignoring given values and recalculating Σfx and Σfx2. Difficulties with coding are due to a lack of understanding about how coding affects the mean and standard deviation, and poor algebraic skills. Students sometimes substitute for the wrong variable, fail to solve equations correctly or get the order of operations the wrong way around. Students should be reminded that they must be precise in their use of language and use the correct terms such as 'median'. 'range' or 'inter-quartile range' rather than the more general 'average' and 'spread'. Students should also remember to use accurate values throughout calculations to avoid losing marks due to premature rounding.
Key Words Tier 2	Graphs, constant, coordinates, sketch, interpretation, solution, translating, stretching, reflecting, manipulate, effect, represent, transformation	Frequency, range, code, data set.
Key Words Tier 3	Expression, function, constant, variable, term, unknown, coefficient, index, linear, identity, simultaneous, elimination, substitution, factorise, completing the square, intersection, change the subject, cross-multiply, power, exponent, base, rational, irrational, reciprocal, root, standard form, surd, rationalise, exact, manipulate, sketch, plot, quadratic, maximum, minimum, turning point, transformation, translation, polynomial, discriminant, real roots, repeated roots, factor theorem, quotient, intercepts, inequality, asymptote	Mean, median, mode, variance, standard deviation, interquartile range, interpercentile range, outlier, skewness, symmetrical, positive skew, negative skew.
Homework	Book 1 Unit 4 Mixed exercise Mathsgenie website: Sketching and Transforming Curves	Book 1 Mixed exercise Unit 2 Mathsgenie website: Interpolation and Standard Deviation
Assessment	Algebra and Functions unit assessment	
Careers links	Civil Engineering, Chemistry	Chartered Accountant
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Straight Line Graphs	**Representations of Data**
Objectives	The equation of a straight line, including the forms: $y = mx + c$ and $y - y_1 = m(x - x_1)$ and $ax + by + c = 0$. The equation of a line through two given points. The condition for two straight lines to be parallel or perpendicular, including equations of lines parallel or perpendicular to a given line through a given point. The distance between two given points: d = $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ Modelling with straight lines: to represent a real – life situation using mathematical concepts.	Be able to clean data, including dealing with missing data, errors and outliers. Be able to represent data in the forms of histograms, frequency polygons, box and whisker plots and cumulative frequency diagrams. Know how to interpret diagrams (histograms, frequency polygons, box and whisker plots and cumulative frequency diagrams) for single variable data Be able to select or critique data presentation techniques in the context of a statistical problem. Be able to compare data sets and comment on them.

Misconceptions	Students can often become confused with the algebraic workings due to not drawing diagrams or diagrams lacking sufficient detail. A common mistake is to write the correct gradient of line in the form y = mx + c but write it incorrectly when converting the equation into the form ax + by + c = 0.	Many students have difficulties calculating the sizes of bars in histograms, as commented on by one examiner: 'Most were able to state the correct width of the bar but few used frequency densities correctly to find the height, some finding the frequency density ofbut then calculating $\frac{1}{3}\times 2.5$ rather than $2.5\div\frac{1}{3}$. Some identified that 1.5 cm2represented 10 customers but were then unable to use this correctly to find the height … some students had an incorrect class width because they did not realize that the lower-class boundary was 70 not 69.5.'
Key Words Tier 2	Line, formula, straight, point, coordinate, condition, parallel, perpendicular, distance, represent, situation, concept, modelling, product, formula, origin, assumption, create.	Represent, frequency, measure, process, anomaly.
Key Words Tier 3	Equation, bisect, centre, chord, circle, circumcircle, coefficient, constant, diameter, gradient, hypotenuse, intercept, isosceles, linear, midpoint, parallel, perpendicular, proportion, Pythagoras, radius, right angle, segment, semicircle, simultaneous, tangent.	Histogram, box plot, probability density function, cumulative distribution function, continuous random variable, scatter diagram
Homework	Book 1 Unit 5 Mixed exercise Mathsgenie website: The Equation of a Line	Book 1 Mixed exercise Unit 3 Mathsgenie website: Histograms, Box Plots
Assessment		**Data presentation and interpretation**
Careers links	Economics, Environmental Science/Studies	Real Estate Investment Analyst
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management
	Circles	**Forces and Motion**
Objectives	Assumed GCSE knowledge to specifically include: The angle in a semi-circle is a right angle. The perpendicular from the centre to a chord bisects the chord. The perpendicularity of radius and tangent. To find midpoint of a line segment and perpendicular bisectors. The equation of a circle in the form $(x-a)^2+(y-b)^2=r^2$, and $x^2+gx+y^2+hx+k=0$. To find intersections of straight lines and circles. To use tangent and chord properties. To solve problems including circles and triangles.	Understand the concept of a force; understand and use Newton's first law. Be able to draw force diagrams. Be able to find the resultant vector of two or more forces. Understand and use Newton's second law (***F = ma***) for motion in a straight line (restricted to forces in two perpendicular direction or simple cases of forces given as 2D (i, j) vectors); extend to situations where forces need to be resolved (restricted to 2 dimensions). Understand and use Newton's third law; equilibrium of forces on a particle and motion in a straight line; application to problems involving smooth pulleys and connected particle including problems with particles in contact e.g. lift problems. (no resolving forces or use of F = μR)
Misconceptions	The coordinates of the centre of a circle are sometimes given with the negatives. For instance, $(x-3)^2+(y-4)^2=r^2$ can have the incorrect centre as (-3, -4). Students can often become confused with the algebraic workings due to not drawing diagrams or diagrams lacking sufficient detail.	Students are often good at drawing force diagrams, but common errors are omitting arrowheads, incorrectly labelling (e.g. 4 kg rather than 4g) and missing off the normal reaction. Students can easily be confused by the vocabulary, e.g. mixing up 'resultant' and 'reaction'. Pulleys: In past exam questions, most students used an equation of motion for each particle with very few 'single equation' solutions. Students may also mistakenly take the acceleration to be equal to g rather than the value obtained in the question. 2 Vehicles: In exam questions of a car-and-trailer type, students may consider the car and trailer as a single system. Common errors when resolving are: to add a tension force (when there is no rope): to consider the weight; or to confuse the positive and negative directions.
Key Words Tier 2	Circle, angle, intersect, solve, coordinate.	Negligible, smooth, rough, tension, object.
Key Words Tier 3	Equation, bisect, centre, chord, circle, circumcircle, coefficient, constant, diameter, gradient, hypotenuse, intercept, isosceles, linear, midpoint, parallel, perpendicular, proportion, Pythagoras, radius, right angle, segment, semicircle, simultaneous, tangent.	Force, newtons, mass, weight, gravity, thrust, compression, air resistance, reaction, driving force, braking force, resultant, force diagram, equilibrium, inextensible, light, particle, uniform, pulley, string, retardation, free particle.
Homework	Book 1 Unit 6 Mixed exercise Mathsgenie website: The Equation of a Circle	Book 1 Mixed exercise Unit 10 Mathsgenie website: 2D Vectors, F = ma
Assessment	Coordinate geometry end of unit assessment	**Forces and Newton's Laws**
Careers links	Electrical/Electronic Engineering, Geology/Earth Sciences	Manufacturing engineer
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management

	Algebraic Methods	Correlation
Objectives	To simplify algebraic fractions by factorising the numerator and/or the denominator The division of a polynomial by $(x \pm a)$. The Factor theorem for division of f(x) by $(x \pm a)$ and $(ax \pm b)$. Factorising cubic expressions of the form $ax^3 + bx^2 + cx + d$. Methods of Proof: • Proof by Deduction • Proof by Exhaustion • Disproof by Counter Example	Know how to interpret scatter diagrams and regression lines for bivariate data. Recognise explanatory and response variables. Be able to make predictions using the regression line and understand its limitations. Understand informal interpretation of correlation. Understand correlation does not imply causation. Recognise and interpret possible outliers in data sets and statistical diagrams.
Misconceptions	Students often forget to give a written conclusion as the final part of their proof. When solving cubic equations, mistakes are sometimes made when substituting in negative values of *x*, particularly with the cubic term. Some students try to use the long division method to factorise quadratics which can be more easily solved by factorisation. Students often lose marks when asked to prove whether an expression is divisible by or a multiple of a constant. Encourage them to consider the variable as an odd and an even value. Students often lose marks by not concluding that a squared term can never be negative.	Students often fail to remember that the order of variables is important. The regression line of y on x will be different from the regression line of x on y. Students sometimes confuse interpolation and extrapolation. Another typical mistake is to make predictions for the independent variable rather than the dependent one. Correlation can only be used to describe data that shows linear relationship.
Key Words Tier 2	Simplify, prove, proof, disproof, deduction, manipulate, counter-example, exhaustion, assumptions, conclusion, therefore, conjecture, prediction, implies, converse, sufficient.	Plot, describe, interpret, determine.
Key Words Tier 3	Polynomials, factorisation, quadratic, cubic, quartic, rational number, fully factorise, factor, expand.	Scatter diagram, bivariate data, linear regression, explanatory (independent) variables, response (dependent) variables interpolation, extrapolation, product moment correlation coefficient (PMCC).
Homework	Book 1 Unit 7 Mixed exercise Mathsgenie website: The Factor Theorem and Algebraic Division, Proof	Book 1 Mixed exercise Unit 4 Mathsgenie website: Correlation and Regression
Careers links	Engineering (General), Engineering (General)	Oil and gas engineering
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	The binomial expansion	**Probability**
Objectives	The use of Pascal's triangle The use of the notations $n!$ and $\binom{n}{r}$. The expansion of $(1+x)^n$, for positive integer n, using the binomial series. To solve binomial problems. To use the binomial expansion to find simple approximations for complicated functions.	Be able to use terminology related to probability (e.g. outcomes, experiment, event, sample space, etc.). Be able to use tree diagrams, Venn diagrams and two-way tables. Understand and be able to use mutually exclusive **P(A or B) = P(A) + P(B)** and independent events **P(A and B) = P(A) x P(B)** when calculating probabilities. Be able to make links with discrete and continuous distributions. Understand and be able to use probability formulae using set notation.
Misconceptions	Students often forget that the power rule applies when raising terms such as $(ax)^n$. For example, students incorrectly write this as ax^n instead of $a^n x^n$. Often, students forget to convert expressions in the form $(a + x)^n$ to $(1 + x)^n$.	Sample space, exclusive event, complementary event, discrete random variable, continuous random variable, mathematical modelling, independent, mutually exclusive, Venn diagram, tree diagram. Students may confuse 'independent' and 'mutually exclusive'. Using a diagram almost always helps students to answer probability questions. When drawing a Venn diagram, students should remember to include a box defining the universal set.
Key Words Tier 2	Adjacent, expansion, notation, general, approximate.	Frequency, region, outcome, modelling.
Key Words Tier 3	Binomial, coefficient, probability, factorial, factorisation, quadratic, cubic, quartic, fully factorise, factor, expand.	Sample space, exclusive event, complementary event, discrete random variable, continuous random variable, mathematical modelling, independent, mutually exclusive, Venn diagram, tree diagram.
Homework	Book 1 Unit 8 Mixed exercise Mathsgenie website: The Binomial Expansion	Book 1 Mixed exercise Unit 5 Mathsgenie website: Probability
Assessment	Further Algebra (Binomial, Factor Theorem) unit assessment **MOCK EXAM – Pure 1**	**Probability**
Careers links	Mathematics, Medicine	Telecommunication engineer

Employability skills	Aiming high Leadership Presenting Critical thinking	Literacy Independence Teamwork Analytical thinking	Creativity Listening Problem solving Time management	Numeracy Communication Staying positive	Aiming high Leadership Presenting Critical thinking	Literacy Independence Teamwork Analytical thinking	Creativity Listening Problem solving Time management	Numeracy Communication Staying positive
	Trigonometric Ratios				**Statistical Distributions**			
Objectives	The use of the Sine and the Cosine Rules. The area of a triangle in the form $\frac{1}{2}ab\sin C$. To solve triangle problems. To sketch the graphs of sine, cosine and tangent functions To review basic trig graphs, their graphs symmetries and periodicity.				Understand and use simple, discrete probability distributions. Understand discrete uniform distribution. Understand and know the binomial distribution as a model and its criteria. Calculate probabilities, including cumulative probabilities, using the binomial distribution. Understand the meaning of a probability mass functions. Be able to use your calculator to find the individual or cumulative binomial probabilities.			
Misconceptions	Students often mislabel their diagrams, so the angle and opposite edge do not have the respective upper- and lower-case letters. Problems involving an angle to be found using the Sine Rule can have two solutions. When transforming graphs, students should use sketched diagrams are mistakes are often made when working algebraically.				The most common difficulty is with manipulating inequalities: 'A significant number of students were unable to cope with the expression $\mathrm{P}(5 \le X < 11)$. There were students who translated this expression into the more convenient form $\mathrm{P}(5 \le X \le 10)$ and then in turn transformed this into an equivalent form that can be applied to the table of cumulative probabilities: $\mathrm{P}(X \le 10) - \mathrm{P}(X \le 4)$. However, there were also many instances of incorrect versions such as: $\mathrm{P}(X < 11) - \mathrm{P}(X \ge 5)$, $\mathrm{P}(X \le 10) + \mathrm{P}(X \ge 5)$, $\mathrm{P}(X \le 10) - (1 - \mathrm{P}(X \ge 5))$ and P(X ≤ 11) – either P(X ≤ 5) or P(X ≤ 4).' In a similar vein, students have a tendency to write, for example, P(X> 2) as 1 – P(X ≤ 1) instead of 1 – P(X ≤ 2).			
Key Words Tier 2	Interval, periodic, amplitude, inverse, degree, identity, symmetry, opposite, adjacent.				Outcome, model, distribution, independent.			
Key Words Tier 3	Sine, cosine, tangent, function, angle of elevation, angle of depression, bearing, special angles, unit circle, hypotenuse, intercept.				Binomial, probability, discrete distribution, discrete random variable, uniform, cumulative probabilities.			
Homework	Book 1 Unit 9 Mixed exercise Mathsgenie website: Sine Rule, Cosine Rule, Area of Any Triangle				Book 1 Mixed exercise Unit 6 Mathsgenie website: Discrete Random Variables			
Assessment					**Statistical Distributions**			
Careers links	Mechanical Engineering, Optometry				Patent examiner, Data scientist			
Employability skills	Aiming high Leadership Presenting Critical thinking	Literacy Independence Teamwork Analytical thinking	Creativity Listening Problem solving Time management	Numeracy Communication Staying positive	Aiming high Leadership Presenting Critical thinking	Literacy Independence Teamwork Analytical thinking	Creativity Listening Problem solving Time management	Numeracy Communication Staying positive
	Trigonometric Identities and Equations				**Hypothesis testing**			
Objectives	The use of the CAST diagram or angles in all four quadrants. The exact trigonometrical values for common angles. To know and use the trigonometric identities of $\tan\theta = \frac{\sin\theta}{\cos\theta}$. and $\sin^2\theta + \cos^2\theta = 1$. To solve simple trigonometrical equations To solve more complex trigonometrical equations of the form $\sin(x + 30) = 0.5$ for $-180 \le \theta \le 180$ $\cos 2x = \frac{\sqrt{3}}{2}$ for $0 \le \theta \le 2\pi$ To solve trigonometrical equations by using trigonometric identities				Understand the language and concept of Hypothesis Testing developed through a binomial model. Understand and be able to write null hypothesis; alternative hypothesis and find significance levels. Be able to find critical values of a binomial distribution using tables. Be able to carry out one-tailed tests and two-tailed tests, find the critical region, acceptance region; p-value. Carry out hypothesis testing using the binomial distribution and interpret the results in context. Understand that a sample is being used to make an inference about the population and appreciate the significance level is the probability of incorrectly rejecting the null hypothesis.			
Misconceptions	When solving trigonometric equations students lose marks in the following ways: - not finding all the solutions within the correct range - including solutions that fall outside of the given range - giving solutions for the transformed equation rather than x. For instance, giving solutions for 2x or x + 30° rather than x.				Emphasise the importance of stating hypotheses clearly using the correct notation. Similarly, correct notation is important when describing the critical region: 'There were still a few students using incorrect notation for critical regions: P($X \le 1$), for example, is not a critical region: it is a probability.' The most common error in these sorts of questions include not writing a clear conclusion in the context of the question. Students either omit the context or sometimes fail to give any conclusion to their calculations.			

Key Words Tier 2	Interval, periodic, amplitude, inverse, degree, identity, symmetry, opposite, adjacent.	Hypotheses, alternative, assume, reject, critical, associated, compare.
Key Words Tier 3	Sine, cosine, tangent, function, special angles, unit circle, hypotenuse, principal value, acute, ratio.	Significance level, one-tailed test, two-tailed test, test statistic, null hypothesis, alternative hypothesis, critical value, critical region, acceptance region, p-value, binomial model, accept, reject, sample, inference.
Homework	Book 1 Unit 10 Mixed exercise Mathsgenie website: Solving Trigonometric Equations	Book 1 Mixed exercise Unit 7 Mathsgenie website: Binomial Hypothesis Testing
Assessment	Trigonometry unit assessment	**Statistical Hypothesis Testing**
Careers links	Physiotherapy, Statistics	Management consultancy
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Vectors	**Variable acceleration**
Objectives	The representation of vectors in 2 dimensions. The magnitude and direction of a vector. Unit vectors The addition of vectors. The multiplication of a vector by a scalar. Position vectors, including the distance between two points. Solving geometrical problems with vectors • Ratio Theorem: to divide a line segment with a point • Comparing coefficients Use vectors to solve problems in pure mathematics and in context (speed, velocity, etc.)	Understand that displacement, velocity and acceleration may be given as functions of time. Use calculus (differentiation) in kinematics to model in a straight line for particle moving with variable acceleration $v = \frac{ds}{dt}$ and $v = \frac{dv}{dt} = \frac{d^2v}{dt^2}$. Understand that gradients of the relevant graphs link to rates of change. Know how to find max and min velocities by considering zero gradient and understand how this links to actual motion (ie acceleration=0). Use calculus (integration) in kinematics to model motion in a straight line for a particle moving under the action of a variable force. $s = \int v\,dt$ and $v = \int a\,dt$. Understand area under a graph is the integral, which leads to a physical quantity. Use calculus to derive constant acceleration formulae. (Know how to use initial conditions to calculate the constant of integration and refer back to the original problem)
Misconceptions	Some students lose marks by writing the magnitude of a vector as a negative. When writing vectors in i and j notation, some students incorrectly think of it as a coordinate pair and write 3i – 2j as (3i, -2j). Some students get confused knowing when a vector gives a direction or a position.	Students who draw sketches of the situation are often more successful in reaching the correct solution, so you should continue to encourage this wherever possible. Students often ignore or don't recognise the difference between displacement and distance and so may end up discarding negative values without considering how they should be interpreted. Students can easily forget that if the velocity becomes negative, for example when a particle stops and changes direction, they need to split the integral to calculate distance rather than displacement.
Key Words Tier 2	Direction, component, dimension, opposite, respectively.	Express, condition, area, draw, sketch.
Key Words Tier 3	Vector, scalar, magnitude, parallel, perpendicular, modulus, ratio, collinear, scalar product, position vectors.	Distance, displacement, velocity, speed, constant acceleration, variable acceleration, retardation, deceleration, gradient, area, differentiate, integrate, rate of change, straight-line motion, with respect to time, constant of integration, initial conditions.
Homework	Book 1 Unit 11 Mixed exercise Mathsgenie website: Vectors	Book 1 Mixed exercise Unit 11 Mathsgenie website: Variable Acceleration
Assessment	Vectors unit assessment	**Kinematics 2 (variable acceleration)**
Careers links	Physics, Pharmacy	R & D Engineer
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Differentiation	**Regression, correlation and hypothesis testing**
Objectives	Introduction to Calculus: In this unit the notations y or f(x) may be used and the notations $\frac{dy}{dx}$ or f'(x). The derivative of f(x) as the gradient of the tangent to the graph of y = f(x) at a point. The gradient of the tangent as a limit.	Understand exponential models in bivariate data. Be able to change the variable in a regression line to estimate coefficients in an exponential model. Understand correlation coefficients and be able to calculate product moment correlation coefficient (PMCC - calculator only).

	Interpretation as a rate of change, i.e. knowledge that $\frac{dy}{dx}$ is the rate of change of y with respect to x. Differentiation from first principles for small positive integer powers and $sinx$ and $cosx$ The differentiation of x^n and related sums and differences. To include expressions, like $(2x+1)(3x-4)$ or $\frac{x^2+3x-6}{4x^{\frac{1}{2}}}$ Application of Differentiation to gradients of tangents and normals. Increasing and decreasing functions. Second order derivatives. Stationary points. Sketching the gradient function for a given curve. Modelling with differentiation, rate of change.	Interpret a correlation coefficient using a given p-value or critical value (calculation of correlation coefficients is excluded). Be able to conduct a hypothesis test for a correlation coefficient.
Misconceptions	A small percentage of students confuse differentiation with integration when answering exam questions. Some students use the second derivative to determine whether a function is increasing or decreasing when they should use f'(x) ≥ 0 or f'(x) ≤ 0. When asked to find the gradient of a tangent to a point on a curve, some students incorrectly make the gradient of the curve equal to zero and attempt to find x. Students can struggle knowing the conditions for maxima and minima turning points. Some students lose marks in their differentiation by not dropping the constant in the original function and not simplifying surds. When asked to find maximum and minimum turning points, some students substituted a value of x on either side of f'(x)=0, which requires more work than using the second derivatives. Exam questions often link applying differentiation to volume and surface area. As a result, some students lose marks deriving the volume or surface area equations, leading to incorrect derivatives.	Notation and stating a conclusion are the most common errors: 'some students failed to state their hypotheses in terms of ρ. Common errors include failing to ensure that critical values match the alternative hypothesis and giving conclusions that do not include a reference to the context.
Key Words Tier 2	Rational, increasing, decreasing, maximum, minimum.	Assume, explain, interpret, sample, alternative, critical.
Key Words Tier 3	Differentiation, derivative, first principles, rate of change, constant, tangent, normal, stationary point, point of inflection, integer, calculus, function, parallel, perpendicular.	Hypotheses, significance level, one-tailed test, two-tailed test, test statistic, null hypothesis, alternative hypothesis, critical value, critical region, acceptance region, p-value, binomial model, correlation coefficients, product moment correlation coefficient, population coefficient, inference, mean, normal distribution, variance, assumed variance, linear regression, interpolation, extrapolation, coded data
Homework	Book 1 Unit 12 Mixed exercise Mathsgenie website: Differentiation from First Principles, Differentiation	Book 2 Mixed exercise Unit 1 Mathsgenie website: Correlation Hypothesis Testing, Non Linear Regression
Assessment	Differentiation unit assessment	**Regression and correlation**
Careers links	Accountancy, Psychology	Financial Software Developer, Financial Engineer
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Exponentials and Logarithms	**Conditional probability**
Objectives	Exponential Functions: The curve y = a^x and y = e^x and their basic transformations. Exponential modelling: rate of increase/decrease The inverse of exponential functions are called logarithms. $\log_a n = x$ is equivalent to $a^x = n$ ($a \neq 1$) The laws of logarithms, to include the following	Be able to use set notation for probability. Understand and be able to use conditional probability. P$(A\|B)$ = P$(A\|B')$ = P(A) and P$(B\|A)$ = P$(B\|A')$ = P(B). Solve conditional probability problems using two-way tables and Venn diagrams. Be able to use probability formulae to solve problems. P(A ∪ B) = P(A) + P(B) – P(A ∩ B) and P$(B\|A)$ = $\frac{P(B\|A)}{P(A)}$. Modelling with probability, including critiquing assumptions made and the likely effect of more realistic assumptions.

	$\log_a x + \log_a y = \log_a xy$ $\log_a x - \log_a y = \log_a \frac{x}{y}$ $k \log_a x = \log_a (x^k)$ $\log_a \left(\frac{1}{x}\right) = -\log_a x$ $\log_a a = 1$ Solving equations using logarithms Working with natural logarithms. ln$x$ = $\log_e x$ Logarithms and non-linear data Use of Logarithmic graphs to estimate parameters in relationships of the form $y = ax^n$ and $y = kb^x$ given data for x and y Plot $log\ y$ against $log\ x$ and obtain a straight line where the intercept is $log\ a$ and the gradient is n. Plot $log\ y$ against x and obtain a straight line where the intercept is $log\ k$ and the gradient is $log\ b$	
Misconceptions	Errors seen in exam questions where students have to sketch exponential curves include: stopping the curve at x = 0; getting the wrong y-intercept; and believing the curve levels off to y = 1 for x < 0. When using laws of logs to answer proof or 'show that' questions, students must show all the steps clearly and not have jumps in their working out.	Mistakes tend to involve the use of the conditional probability formula. For example, wrongly assuming independence and putting P(A) × P(B) rather than $\mathrm{P}(A \cap B)$ as the numerator or the incorrect probability in the denominator. Students should be careful not to make assumptions for which there is no basis. For example, assuming two events are independent without having evidence or reasons for such an assumption.
Key Words Tier 2	Equivalent, reflection, recognise, solve.	Event, union, intersection, complement, independent, random, conditional.
Key Words Tier 3	Expontential, exponent, power, logarithm, base, intital, rate of change, compound interest	Sample space, exclusive event, complementary event, discrete random variable, continuous random variable, mathematical modelling, independent, mutually exclusive, Venn diagram, tree diagram, set notation, conditional probability, two-way tables, critiquing assumptions.
Homework	Book 1 Unit 14 Mixed Exercise Mathsgenie website: Exponentials and Logarithms	Book 2 Mixed exercise Unit 2 Mathsgenie website: Probability
Assessment	Exponentials and logarithms unit assessment	**Conditional Probability**
Career links	Computer science, sports science/physical education	Quantitative Analyst, Quantitative Research Analyst
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Integration	**The normal distribution**
Objectives	Indefinite Integration as the reverse of differentiation. Finding functions: to include the constant of integration. The integration of x^n. To include expressions, like $\frac{3}{4}x^5 - 4\sqrt{x}$ or $\frac{(x+2)^2}{x^{\frac{1}{2}}}$ Given f'(x) and a point on a curve, candidates should be able to find an equation of the curve in the form y = f(x). Definite integrals: to calculate an integral between two limits. Areas under curves by using definite integration Areas under the x – axis: when the area is bounded by a curve and the x – axis is below the x – axis the integral returns a negative answer. Areas between curves and lines. The use of definite integrals together with areas of trapeziums and triangles to find more complicated areas on graphs.	Understand the properties of the Normal distribution. Knowledge of the shape and the symmetry of the normal distribution curve is required. Find percentage points and probabilities using the normal distribution Calculate values on a standard normal curve. Find unknown means and/or standard deviations for a normal distribution (questions may involve the solution of simultaneous equations). Know the points of inflection of a normal distribution are at $x = \mu \pm \sigma$ (do not need to derive). Know when and how to approximate a binomial distribution using a normal distribution. Select an appropriate probability distribution for a context, with appropriate reasoning, including recognising when the Binomial or Normal model may not be appropriate. Conduct a statistical hypothesis test for the mean of a normal distribution with known, given or assumed variance and interpret the results in context.
Misconceptions	Students sometimes have difficulty when integrating expressions involving negative indices. Forgetting to add + c when working out indefinite integrals is also a very common mistake. Lack of algebraic fluency can cause problems for some students, particularly when negative/fractional indices are involved or when a negative number is raised to a power. Arithmetic slips are also a common cause of lost marks, often when negative numbers are substituted and subtracted after integration.	Main errors are due to confusion between probabilities and Z values, particularly when it comes to notation, and not using the full four decimal place accuracy in calculations. An emphasis on using diagrams alongside the calculations should help address some of the difficulties. Correctly applying continuity corrections can prove difficult with students either not applying one or otherwise adding 0.5 rather than subtracting or vice versa.

	Students are generally more successful if they expand any brackets before attempting to integrate the function.	Common errors in exam situations include: not expressing hypotheses precisely enough; using an incorrect parameter or not using a parameter at all; incorrectly applying the continuity correction; and not giving a conclusion or answer to the question using the given context.
Key words Tier 2	Apply, separately, value, solve, area	Population, symmetrical, distribution, parameters.
Key Words Tier 3	Calculus, differentiate, integrate, reverse, indefinite, definite, constant, evaluate, intersection	Binomial, discrete distribution, discrete random variable, uniform, cumulative probabilities Normal, mean, variance, continuous distribution, histogram, inflection, appropriate probability distribution.
Homework	Book 1 Unit 13 Mixed exercise Mathsgenie website: Integration	Book 2 Mixed exercise Unit 3 Mathsgenie website: The Normal Distribution, Mean of Normal Distribution Hypothesis Testing, Using the Normal Distribution to approximate the Binomial
Assessment	Integration unit assessment	**The normal distribution**
Career links	Architecture, Management Studies	Government research and laboratories, market researcher
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Proof and Partial Fractions	**Moments**
Objectives	Proof by contradiction Simplifying algebraic fractions: add, subtract, multiply and divide algebraic fractions Partial Fractions: • to include denominators with 2 or 3 distinct linear factors • repeated linear factors • problems where the degree of the numerator is equal to or exceeds the degree of the denominator (improper fractions with the use of algebraic division)	Be able to calculate the turning effect of a force applied to a rigid body. Be able to calculate the resultant moment of a set of forces acting on a rigid body. Solve problems involving uniform rods in equilibrium. Solve problems involving non-uniform rods. Solve problems involving rods on the point of tilting.
Misconceptions	Some students mistakenly think that substituting several values into an expression is sufficient to prove the statement for all values. Similarly, for example, referring to a graph to prove that the gradient is always positive rather than completing the square will not gain marks for a proof. Students need to practise factorising quadratics as this is often done incorrectly. The most common errors include failing to include all necessary brackets, casual miswriting of signs part way through calculations and not dealing correctly with factors. Particular care with signs needs to be taken when a fraction follows a minus sign. Some students will set up and solve simultaneous equations rather than using values of x to work out missing constants. Ensure students are aware of the most efficient methods for solving different types of problem so they do not waste time in exam situations.	Many students made their life more difficult than necessary by not taking the easy resolving option and using two moments equations resulting in simultaneous equations which can be difficult to solve. Clear diagrams can help to overcome some errors such as using distances from the wrong point or missing forces (often the weight). Students should also be reminded to read the question carefully and give their answer in the correct form – being particularly careful not to mix up weight and mass.
Key Words Tier 2	Proof, verify, deduction, contradict, assumption, contradiction.	Clockwise, anti-clockwise, sum, direction, support, string.
Key Words Tier 3	Rational, irrational, square, root, prime, infinity, square number, quadratic, expansion, trigonometry, Pythagoras, polynomial, numerator, denominator, factor, difference of two squares, quadratic, power, index, coefficient, degree, squared, coefficients, improper, identity, algebraic fraction, partial fraction.	Moment, turning effect, sense, Newton metre (N m), equilibrium, reaction, tension, rod, uniform, non-uniform, centre of mass, resolve, tilting, 'on the point', concurrent.
Homework	Book 2 Unit 1 Mixed exercise Mathsgenie website: Proof by Contradiction, Partial Fractions	Book 2 Mixed exercise Unit 4 Mathsgenie website: Moments
Assessment	Proof, algebraic and partial fractions unit assessment **MOCK EXAM – Pure 1 & 2**	**Moments**
Careers links	Investment banking, Meteorology	Space/aircraft industry
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management

	Sequences and Series	Forces and friction
Objectives	Arithmetic sequences (progressions). Common difference, n^{th} term or general term. Arithmetic Series: the sum of the terms of an arithmetic sequence. Candidates need to be able to prove this formula. Geometric sequences. Common ratio, n^{th} term or general term. Geometric Series: the sum of the terms of an geometric sequence. Candidates need to be able to prove this formula. The sum to infinity of a convergent geometric series (- 1 < r < 1). Sigma notation to signify a sum (∑). Recurrence relations: Sequences generated by a formula for the n^{th} term or a simple relation of the form $x_{n+1} = f(x_n)$. Encourage the use of the ANS button on a calculator to obtain the terms for a recurrence relation. Modelling with series: real – life situations using mathematical concepts.	Be able to resolve forces into components and the use of the triangle law. Resolving forces in 2-dimension, equilibrium of a particle under coplanar forces. Solve problems involving smooth and rough inclined planes. (Resolve parallel to and at right angles to the plane). Understand and be able to use the coefficient of friction; motion of a body on a rough surface; limiting friction and statics. Understand and use the $F \leq \mu R$ model for friction.
Misconceptions	When working with formulae for sequences and series, it is important that students state the relevant formula before substituting so that method marks can be awarded even if there is a numerical slip. A fairly common error is to mix up the formulae for sums and terms, for example finding Sn rather than Un and vice-versa. When asked to find the limit of u_n some candidates use the sum to infinity of a geometric series	When resolving common errors are: to omit g; sign errors; reversal or confusion* of when to use cos and/or sin; to omit one force (usually weight). Students may also easily get confused by the vocabulary and mix up 'resultant' and 'reaction'. Students are often good at drawing force diagrams, but common errors are omitting arrowheads, incorrectly labelling (e.g. 4 kg rather than 4g) and missing off the normal reaction or friction forces. Students can sometimes struggle to work out the direction of the frictional force. Some students may mistakenly think that the coefficient of friction changes if the mass of an object or the angle of the slope changes.
Key Words Tier 2	Consecutive, limit, order, sum, difference.	Apply, direction, component, tension, light, smooth, rough, negligible.
Key Words Tier 3	Sequence, series, finite, infinite, summation notation, Σ(sigma), periodicity, convergent, divergent, natural numbers, arithmetic series, arithmetic progression (AP), common difference, geometric series, geometric progression (GP), common ratio, nth term, sum to n terms, sum to infinity (S_∞).	Force, weight, thrust, friction, coefficient of friction, μ, limiting, reaction, resultant, magnitude, direction, bearing, force diagram, equilibrium, inextensible, particle, uniform, perpendicular.
Homework	Book 2 Unit 3 Mixed exercise Mathsgenie website: Recurrence Relations, Arithmetic Sequences and Series, Geometric Sequences and Series	Book 2 Mixed exercise Unit 5 Mathsgenie website: Resolving Forces, Resolving Forces 2
Assessment	Sequences and series unit assessment	**Forces at an angle**
Careers links	Economics, computer programming	Quality Assurance Engineer
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Functions and Graphs	**Projectiles**
Objectives	Definition of a function: a function may be a one-one mapping or a many-one mapping: the notation $f: x \rightarrow$ and $f(x)$ will be used. Domain and range of functions. Composite functions: fg(x) means apply g first, then apply f; fg(x) = f(g(x)) The modulus function and their graphs, to include $y = \lvert f(x) \rvert$ and $y = \lvert ax + b \rvert$ The transformation from $y = f(x)$ to $y = \lvert f(x) \rvert$ and $y = f\lvert x \rvert$. Knowledge of the effect of simple transformations on the graph $y = f(x)$ as represented by $y = af(x)$, $y = f(ax)$, $y = f(x) + a$, $y = f(x + a)$, $y = -f(x)$, $y = f(-x)$. Inverse functions, and their graphs, $y = f^{-1}(x)$. The graphs of $y = f(x)$ and $y = f^{-1}(x)$ are reflections of each other in the line $y = x$. Solving modulus problems	Be able to resolve velocity into horizontal and vertical components Be able to find the time of flight of a projectile. Be able to find the range and maximum height of a projectile. Be able to derive formulae to find the greatest height, the time of flight and horizontal range (for a full trajectory). Know how to modify projectile equations to take account of the height of release. Be able to derive and use the equation of the path of a projectile. Be able to model motion under gravity in a vertical plane using vectors.

Misconceptions	Students may find it difficult to sketch graphs involving modulus functions particularly if they are combined with other functions, for example logarithms. In exam situations, often only the highest scoring students are able to solve modulus equations with x on both sides, or inequalities which involve the modulus function. Students can often successfully find the range in exam questions, but some give their answer in terms of x rather than f(x). When finding inverse functions, students need to remember to swap x and y. When describing why a function does not have an inverse, students should be advised to answer this question as "because it is not one to one" or "because it is many to one". Students often score well on questions which involve describing geometrical transformations, but incorrect use of terminology will lose marks. Students must use the correct terms: stretch, scale factor and translation. Students also need to be aware that the order of transformations is often important.	Students often find projectile questions challenging, sometimes confusing the horizontal and vertical aspects of the motion, for example by including the horizontal component of velocity in an equation for the vertical motion. Other common mistakes include considering only one component of velocity when finding speeds and making sign errors when producing quadratic equations (to find t).
Key Words Tier 2	Translate, inverse, stretch, reflect, composite, inverse, transformation.	Model, component, project, range.
Key Words Tier 3	Function, mapping, domain, range, modulus, one to one, many to one, mappings, f(x), fg(x), $f^{-1}(x)$.	Projectile, vertical, horizontal, component, acceleration, gravity, initial velocity, vector, angle of projection, position, trajectory, parabola.
Homework	Book 2 Unit 2 Mixed exercise Mathsgenie website: Functions, Transforming Graphs	Book 2 Mixed exercise Unit 6 Mathsgenie website: Projectiles
Assessment	Functions and modelling unit assessment	**Applications of kinematics (Projectiles)**
Careers links	Veterinary Medicine, Research Scientist	Civil and structural engineer
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Binomial Expansion	**Applications of forces**
Objectives	The Binomial series for rational n. Expanding $(1 + x)^n$ and $(a + bx)^n$. Be aware expansion is valid for $\left\|\frac{bx}{a}\right\| < 1$ To include the expansion of rational functions by decomposition into partial fractions. To use the binomial expansion to find simple approximations for complicated functions.	Understand that a body is in equilibrium under a set of concurrent (acting through the same point) forces if their resultant force is zero. Know that vectors representing forces in equilibrium form a closed polygon. Understand how to solve problems involving equilibrium of a particle under coplanar forces, including particles on inclined planes and 2D vectors. Be able to solve statics problems for a system of forces which are not concurrent (e.g. ladder problems), thus applying the principle of moments for forces at any angle. Know and understand the meaning of Newton's second law. Be able to formulate the equation of motion for a particle in 1 – and 2 - dimensional motion where the resultant force is mass x acceleration. Be able to formulate and solve separate equations for connected particles, where one particle could be on an inclined and/or rough plane.
Misconceptions	When expanding $(1 + 4x)^{\frac{1}{2}}$ most students got the first two terms of the expansion correct, but often there was a mistake in the x2 term, with 4x becoming just x being the common error. Some students made arithmetic errors with 42, by failing to actually square the 4, and others failed to simplify the binomial coefficient correctly. When expanding an expression of the form (a + x)n a common error is to write this as $a(1 + \frac{x}{a})n$ rather than $an(1 + \frac{x}{a})n$. Other errors include algebraic errors when combining two expansions, doing more work than is necessary when, for example, only terms up to x2 are required, including the equality in the expression for the range of valid values for x and lack of understanding when using the modulus symbol (writing expressions such as $\|x\| < -4$).	Students are often good at drawing force diagrams, but common errors are omitting arrowheads, incorrectly labelling (e.g. 4 kg rather than 4g) and missing off the normal reaction or friction forces. Students can sometimes struggle to work out the direction of the frictional force. Common errors in questions involving moments are ignored the weight of the ladder, sine/cosine confusion and missing a distance in one or more terms. Common errors candidates make include: confusing the terms 'resultant' and 'reaction'; incorrectly treated the scenario as a statics problem and assuming the forces are in equilibrium; omitting g from the weight term; and, more rarely, including g in the 'ma' term.
Key Words Tier 2	Expansion, theorem, approximation, substitution.	Act, consider, limit, opposite, apply, direction, component, tension, light, smooth, rough, negligible.

Key Words Tier 3	Binomial, integer, rational, power, index, coefficient, validity, modulus, factorial, ^{n}Cr, combinations, Pascal's triangle, partial fractions, approximation, converges, diverges, root.	Force, resultant, component, resolving, plane, parallel, perpendicular, weight, tension, thrust, friction, air resistance, reaction, driving force, braking force, force diagram, equilibrium, inextensible, light, negligible, particle, rough, smooth, incline, uniform, friction, coefficient of friction, concurrent, coplanar.
Homework	Book 2 Unit 4 Mixed exercise Mathsgenie website: The Binomial Expansion	Book 2 Mixed exercise Unit 7 Mathsgenie website: Connected Particles, Statics of Rigid Bodies
Assessment	Binomial Theorem unit assessment	**Applications of forces**
Careers links	Data analyst, Law	Mechanical Maintenance Engineer
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Radians	**Further kinematics**
Objectives	Radian measure. 2π = 360°, π = 180° and 1 radian = $\frac{180°}{\pi}$. Arc length using the formula $s = r\theta$ Area of sector and segments using the formulae $A = \frac{1}{2}r^2\theta$ and $A = \frac{1}{2}r^2(\theta - sin\theta)$ respectively. Solving trigonometric equations in radians Small angles approximations: $sin\theta \approx \theta$, $tan\theta \approx \theta$ and $cos\theta \approx 1 - \frac{\theta^2}{2}$.	Work with vectors for displacement, velocity and acceleration when using the vector equations of motion. Use calculus (differentiation and integration) with harder functions of time involving variable acceleration. Differentiate and integrate vectors with respect to time.
Misconceptions	A common exam mistake is for students to have their calculators set in the wrong mode resulting in the loss of accuracy marks. Students may try to use these approximations when angles are measured in degrees rather than radians.	Candidates are generally able to use suvat equations in 2D to find unknown heights, velocities etc. However, some common errors are: finding a solution in vector form and not extracting one component e.g. to find the height; incorrectly finding velocity rather than speed and vice versa; and equating scalars and vectors and forgetting to split e.g. velocities into i and j components. Some common errors students make include: forgetting the constant of integration; giving the final answer as a vector when the question asked for the speed; and not being careful about changes of direction and so, for example, finding the displacement rather than the distance travelled.
Key Words Tier 2	Opposite, exact, symmetry, contain, measure, infinity, identity, proof, approximation, interval, infinity, adjacent, sector, segment, area, solve.	Component, turning point, express, condition, area.
Key Words Tier 3	Pythagoras, Pythagorean triple, right-angled triangle, opposite, hypotenuse, trigonometry, sine, cosine, tangent, secant, cosecant, cotangent, SOHCAHTOA, exact, symmetry, periodicity, equation, quadrant, degree, radian, circular measure, asymptote, small angles.	Distance, displacement, speed, velocity, constant acceleration, constant force, variable force, variable acceleration, retardation, deceleration, initial (t=0), stationary (speed=0), at rest (speed= 0), instantaneously, differentiate, integrate.
Homework	Book 2 Unit 5 Mixed exercise Mathsgenie website: Radians, Small Angle Approximations	Book 2 Mixed exercise Unit 8 Mathsgenie website: Kinematics with Vectors, Kinematics with Calculus
Assessment		**Further Kinematics**
Careers links	Product designer, Finance (Fraud investigation)	Medical Engineering
Employability skills	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management	Aiming high, Literacy, Creativity, Numeracy Leadership, Independence, Listening, Communication Presenting, Teamwork, Problem solving, Staying positive Critical thinking, Analytical thinking, Time management
	Trigonometric Functions	
Objectives	Knowledge of secant, cosecant and cotangent and their graphs (y = sec x, y = cosec x and y = cot x); as well as their domains and ranges. Using sec x, cosec x and cot x to simplify expressions, prove identities and solve equations. Knowledge and use of $\sec^2\theta = 1 + \tan^2\theta$ and $\operatorname{cosec}^2\theta = 1 + \cot^2\theta$. Inverse trigonometric functions: Knowledge and use of arcsin, arccos and arctan, their graphs, domains and ranges.	
Misconceptions	The most common errors in these questions involve using wrong notation, for example sin x2 instead of sin2 x, or making algebraic mistakes. Students sometimes struggle to deal with more complicated functions such as cosec (3x + 1) and do not always recognise where trigonometric identities can be used.	

Key Words Tier 2	Opposite, exact, symmetry, contain, measure, infinity, identity, proof, approximation, interval, infinity, adjacent, sector, segment.	
Key Words Tier 3	Pythagoras, Pythagorean triple, right-angled triangle, opposite, hypotenuse, trigonometry, sine, cosine, tangent, secant, cosecant, cotangent, SOHCAHTOA, exact, symmetry, periodicity, equation, quadrant, degree, radian, circular measure, asymptote, small angles.	
Homework	Book 2 Unit 6 Mixed exercise Mathsgenie website: Sec, Cosec and Cot, Trig identities	
Assessment		
Careers links	Air traffic controller, Criminologist	
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	
	Trigonometry and modelling	
Objectives	Knowledge and use of the Addition formulae (Compound angle formulae). Knowledge and use of Double angle formulae Solving trigonometric equations using the addition and double-angle formulae. Simplifying $a\cos x \pm b\sin x$ (The R$\cos(\theta \pm \alpha)$ method). Proving trigonometric identities. **It is essential that students know which formulae are provided in the formulae book and which have to be learnt.** Using trigonometric functions to model real-life situations.	
Misconceptions	The most common errors are sign errors when using the compound and double angle formulae. When writing a $\cos\theta + b\sin\theta$ into the form R$\sin(\theta - \alpha)$ most students found the value of R correctly, the same was not true of the angle α. Some students seemingly failed to notice that α was given as an acute angle. When solving an equation of the form $a\cos\theta + b\sin\theta = c$ many students seemingly could not cope with the result of –39.23° that their calculator gave them and could not get the first solution. In addition, some students found the third quadrant solution only, whereas some found more than two solutions. However, many students did give a fully correct solution, often by using a sketch graph to help them decide where the solutions lay. These questions often prove to be the most demanding on the paper and serve to differentiate between students. Students need to make sure they include all steps in the proof with full explanation.	
Key Words Tier 2	Addition, compound, double, formulae, express.	
Key Words Tier 3	Pythagoras, Pythagorean triple, right-angled triangle, opposite, adjacent, hypotenuse, trigonometry, sine, cosine, tangent, secant, cosecant, cotangent, SOHCAHTOA, exact, symmetry, periodicity, identity, equation, interval, quadrant, degree, radian, circular measure, infinity, asymptote, small angles, approximation, identity, proof.	
Homework	Book 2 Unit 7 Mixed exercise Mathsgenie website: Addition and Double Angle Formulae, R Formulae	
Assessment	Trigonometry unit assessment	
Careers links	Cyber intelligence officer, Insurance underwriter	
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	
	Parametric Equations	
Objectives	Candidates will be expected to sketch a curve from its parametric form.	

5 - 6 lessons	Parametric equations of curves, to include the conversion between Cartesian and Parametric forms. Using trigonometric identities with parametric equations. Points of intersections with parametric equations. Using parametric equations to model real-life situations.	
Misconceptions	Students may have difficulties making any progress with these sorts of questions if they cannot work out which trigonometric identity to apply when eliminating the parameter t.	
Key Words Tier 2	Convert**,** parameter, identity, eliminate, substitute, modelling.	
Key Words Tier 3	Parametric, Cartesian, circle, hyperbola, parabola, ellipse, domain.	
Homework	Book 2 Unit 8 Mixed exercise Mathsgenie website: Parametric Equations	
Assessment	Parametric equations unit assessment	
Careers links	Software developer, Stockbroker	
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	
	Further Differentiation	
Objectives	Differentiation from first principles for $sinx$ and $cosx$. Differentiating e^x, a^x and ln$x$. The chain rule. The product rule. The quotient rule Differentiation of trig functions, to include sin x, cos x, tan x, sec x, cosec x and cot x. Differentiation of inverse trig functions $arcsinx$, $arcosx$ and $arctanx$ Parametric differentiation, to include the equations of tangents and normals. Implicit differentiation Using second derivatives (concave and convex functions, point of inflections). Connected rates of change, writing differential equations.	
Misconceptions	Students often miss out minus signs or add an extra x into the answer when differentiating expressions like $e^{-\frac{1}{4}x}$. Some students mix up $\frac{dx}{dy}$ and $\frac{dy}{dx}$ and others struggle to differentiate functions involving ln. For example, given when differentiating y = ln 6x they write $\frac{1}{6x}$ rather than $\frac{1}{x}$. Common errors involve: not using the method specified; algebraic errors when manipulating expressions; and being unable to identify the need of the product rule and instead simply differentiating the separate parts and multiplying. Students should be encouraged to state " $\frac{dx}{dy}$ = … when x = …", especially when finding a given answer. An easy mistake student may make is to mix up maxima and minima. Most students are able to substitute correctly into a formula for exponential growth and decay. When required to set up an inequality most students showed that they understood the information given and wrote down a correct opening expression, although there was uncertainty over which way the inequality should go. Some then simplified and solved using logarithms efficiently to get the correct answer. Some resorted to trial and improvement which was accepted for full marks if done correctly, but was worth no marks otherwise. When solving equations involving exponentials, knowledge of using logarithms varied widely. Many were unable to deal properly with the coefficient and the exponential term and wrote down equations in which t actually should have cancelled out.	

	Some care needs to be taken when interpreting the answers to exponential growth and decay questions to ensure they are given in the correct form e.g. to the nearest year, second etc.	
Key Words Tier 2	Turning point, maximum, minimum, implicit, product.	
Key Words Tier 3	Derivative, tangent, normal, turning point, stationary point, inflexion, parametric, differential equation, rate of change, quotient, first derivative, second derivative, increasing function, decreasing function.	
Homework	Book 2 Unit 9 Mixed exercise Mathsgenie website: The Chain Rule, The Product Rule, The Quotient Rule, Trigonometric Differentiation, Implicit Differentiation, Cos and Sin from First Principles	
Assessment	Further differentiation **MOCK EXAM – Pure 1 & 2**	
Careers links	Tax adviser, Acoustics consultant	
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	
	Numerical Methods	
Objectives	Locating roots of $f(x) = 0$ by considering changes of sign of $f(x)$. Approximate solution of equations using simple iterative methods, including recurrence relations of the form $x_{n+1} = f(x_n)$. Solve equations approximately using simple iterative methods: be able to draw associated cobweb and staircase diagrams. Solve equations using Newton-Raphson method and other recurrence relations of the form $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$ Use numerical methods to solve problems in context.	
Misconceptions	Students must define f(x) before substituting x-values to find a root. Most students can successfully identify the root of equations. However, there are still many students who then write “change of sign therefore a root” without clarification of where the root lies and hence loose a mark. Marks are sometimes lost unnecessarily if students do not give their answers to the specified number of significant figures or decimal places. Marks will be lost due to using degrees (instead of radians) if functions involve trigonometric terms. Choosing an unsuitable interval will also prevent progress in these questions. Marks are often lost for sign errors and other numerical slips. Students must show full working leading to the correct answer for full marks. Giving a correct answer either without working or following wrong working will result in zero marks.	
Key Words Tier 2	Interval, satisfy, method, rearrange, approximating.	
Key Words Tier 3	Roots, continuous, function, positive, negative, converge, diverge, derivative, tangent, chord, iteration, Newton-Raphson, staircase, cobweb.	
Homework	Book 2 Unit 10 Mixed exercise Mathsgenie website: Iteration, Newton-Raphson, The Trapezium Rule	
Assessment	Numerical Methods unit assessment	
Careers links	Sound engineer, Game designer	
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	
	Further Vectors	
Objectives	3D coordinates and the representation of vectors in 3 dimensions. The magnitude and direction of a 3D vector.	

	Position vectors, including the distance between two points using 3D vectors. Finding angles between 3D vectors and the positive coordinate axes. Solving geometrical problems with 3D vectors (comparing coefficients). Application to mechanics	
Misconceptions	Encourage students to draw diagrams to help their geometrical thinking when answering vector questions. Stress the importance of reading the question carefully and giving answers in the correct way, for example coordinates or column vectors may be requested. Emphasise the importance of good notation. Students do not always understand that AP^2 represents the square of the length AP.	
Key Words Tier 2	Origin, distance, direction, coefficient, plane, compare.	
Key Words Tier 3	Vector, scalar, column, 3D coordinates, vertices, Cartesian, i, j, k, magnitude, angle, position vector, unit vector, orthogonal, vector addition/subtraction	
Homework	Book 2 Unit 11 Mixed exercise Mathsgenie website: 3D Vectors	
Assessment	Further Vectors unit assessment	
Careers links	Quantity surveyor, Radiation protection practitioner	
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	
	Further Integration	
Objectives	Integration of standard functions including x^n , e^x, $\frac{1}{x}$, sin *x*, cos *x*, sec^2 *x*, cosec*x*cot*x*, cosec^2*x*, sec*x*tan*x* and associated functions. Integrating functions in the form of *f(ax + b).* Integration of rational fractions to include problems leading to natural logarithms. (Reverse chain rule). Integration of linear brackets. (Reverse chain rule). Integration using trigonometric identities. Standard results for sin^2 *x* etc. Substitution includes finding a suitable substitution. Integration by parts, including the integration of ln *x*. Integration by parts, including more than one application. Integration of algebraic fractions with the use of partial fractions. Finding the area under a curve given both in cartesian and parametric form. The trapezium rule. The general and particular solution of first order differential equations with separating the variables. Using differential equations to model real-life situations.	
Misconceptions	Mistakes students make when attempting to integrate by substitution include not changing the dx correctly and simply writing it as du, and failing to substitute back to give an expression in x at the end. Common errors when integrating by parts include: choosing u and dv incorrectly (in particular ln x must always be chosen as u); algebraic errors – especially if they do not remove any common factors to outside the integral sign; incorrect coefficients when integrating dv; and sign errors where sin and cos are involved. Partial fractions questions are generally done well though some students attempt to integrate the numerator and denominator separately without using partial fractions. When using the trapezium rule students sometimes mix up the number of strips and the number of x or y values. The other main place marks are lost is not giving the final answer to three significant figures. When forming a differential equation some students wrote down the correct differential equation apparently fully understanding all the information given and interpreting it correctly. However, all sorts of errors abounded in other attempts, some not even involving a derivative, and some with derivatives in x and y. Many had a spurious t and/or h, either as a multiple or power, and the k appeared in a variety of places. Some students did not even form an equation, leaving a proportionality sign in their answer.	

	When solving a differential equation most students knew they were expected to separate the variables and did it correctly, although there were some notation errors in the positioning of dx, at the front rather than the rear of the integrand. Those who failed to separate the variables, just produced nonsense. Many students struggled with the fact that integration by parts or substitution was needed. All students, no matter what their attempt at the integral, could obtain a method mark if they included a constant and tried to find it using the given initial conditions.	
Key Words Tier 2	Replace, identical, adjust, limit.	
Key Words Tier 3	Integral, definite integral, indefinite integral, constant of integration, trapezium, substitution, by parts, area, differential equation, first order, separating variables, initial conditions, general solution, parametric.	
Homework	Book 2 Unit 12 Mixed exercise Mathsgenie website: Trigonometric Integration, Exponential Integration, Integration by Substitution, Integration by Parts, Parametric Integration, Differential Equations	
Assessment	Integration 1 & 2 unit assessment **MOCK EXAM – Pure 1 & 2**	
Careers links	Financial trader, Purchasing and Quality engineer	
Employability skills	Aiming high Literacy Creativity Numeracy Leadership Independence Listening Communication Presenting Teamwork Problem solving Staying positive Critical thinking Analytical thinking Time management	