Indices Surds & Fractions

☐ Use the laws of indices for all rational exponents, including negative and zero indices.

☐ Use and manipulate surds, including rationalising the denominator.

☐ Understand and use the equivalence of surd and index notation.

☐ Find solutions of quadratic equations using the formula & simplify the roots.

Factorising

☐ Manipulate polynomials eg expanding brackets, collecting like terms and factorising.

☐ Find solutions of quadratic equations by factorisation.

Completing the Square

☐ Work with quadratic functions and their graphs

☐ Find solutions of quadratic equations by completing the square

☐ Use the completed square to find the line of symmetry & turning point of a quadratic

Simultaneous Equations

☐ Solve simultaneous equations by elimination and by substitution

☐ Solve simultaneous equations involving quadratics with powers of 2, brackets or fractions

☐ Interpret solutions of simultaneous equations as coordinates of the intersection of graphs

Tailored Tutors
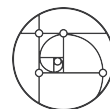
Hidden Quadratics

☐ Solve quadratic equations in a function of the unknown
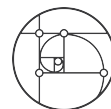
The Discriminant of a Quadratic

☐ Use the discriminant of a quadratic, including the conditions for real and repeated roots

☐ Relate the value of the discriminant to the graph of the quadratic function

The Factor Theorem & Algebraic Division

☐ Use the factor theorem and algebraic division by $(ax \pm b)$ to manipulate polynomials

The Binomial Expansion

☐ Understand and use the binomial expansion of $(a + bx)^n$ for positive integer n

☐ Be able to use the notations $n!$, ^nC_r and $\binom{n}{r}$

☐ Use the binomial expansion to approximate values

☐ Know that $0! = 1$

☐ Know the relationship between binomial coefficients and Pascal's triangle

☐ Understand and know the link to binomial probabilities

Sketching Factorised Polynomials

☐ Sketch curves defined by simple equations, including polynomials

Graph Transformations

☐ Sketch the graph resulting from a simple stretch, reflection or translation

Transformations of Functions

☐ Understand the effect of stretches and translations on the graph of $y = f(x)$

### Sketching Transformations of x^3 and x^4

☐ Apply transformations to cubics or quartics, and sketch the resulting graph

Sketching Transformations of $\frac{1}{x}$ and $\frac{1}{x^2}$

☐ Understand and use proportional relationships and their graphs

☐ Sketch the graphs of $\frac{a}{x}$ and $\frac{a}{x^2}$, including their vertical and horizontal asymptotes

Solving and Sketching Inequalities

☐ Represent linear inequalities, eg $y > x + 1$, graphically

☐ Represent quadratic inequalities, eg $y > ax^2 + bx + c$ graphically

☐ Express solutions of inequalities using set notation

☐ Solve inequalities (with brackets and fractions) algebraically then represent graphically
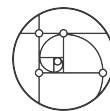
Line Equation

☐ Use the equation of a straight line in the form $y - y_1 = m(x - x_1)$ or $ax + by + c = 0$

☐ Draw a straight line graph given its equation

Line Geometry

☐ Understand the gradient conditions for straight lines to be parallel or perpendicular

☐ Use straight line models in a variety of contexts.

Circle Geometry

☐ Use the equation of a circle in the form $(x - a)^2 + (y - b)^2 = r^2$ to find centre, radius

☐ Complete the square to find the centre and radius of a circle

☐ Know that the angle in a semicircle is a right angle

☐ Know that the perpendicular from the centre of a circle to a chord bisects the chord

☐ Know that the radius of a circle is perpendicular to the tangent to the circle at that point
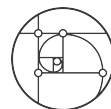
Formulae for Triangles

☐ Use the sine and cosine rule to find an angle and/or a side of a triangle

☐ Use the formula $\frac{1}{2}ab\sin C$ to find the area of a triangle

Vectors

☐ Use vectors in two dimensions, in the form of column vectors and **i** and **j** unit vectors

☐ Calculate the magnitude and direction of vectors

☐ Convert between component and magnitude/direction form

☐ Add vectors diagrammatically and by vector addition

☐ Multiply vectors by scalars then understand their geometrical interpretations

☐ Understand and use position vectors to calculate the distance between two points

☐ Use vectors to solve problems in pure mathematics and mechanics (eg forces)
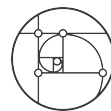
Modelling with Exponential Functions

☐ Know and use the function a^x and its graph, where a is positive

☐ Know and use the function e^x and its graph

☐ Know that the gradient of $e^{kx} = ke^{kx}$ and why this makes exponential models suitable

☐ Use exponential growth and decay in modelling, considering limitations and refinements

Logarithmic Functions

☐ Know and use the definition of $\log_a x$ as the inverse of a^x, where a is positive and $x \geqslant 0$

☐ Know and use the function $\ln x$ as the inverse of e^x, and know and use its graph
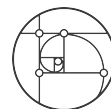
Exponential & Logarithmic Equations

☐ Solve equations of the form $a^x = b$

☐ Solve equations of the form $e^{ax+b} = p$ and $\ln(ax+b) = q$

Linearising Bivariate Data

☐ Use graphs to estimate parameters in relationships of the form $y = ax^n$ and $y = kb^x$

Log Rules

☐ Understand and use $\log_a x + \log_a y = \log_a(xy)$

☐ Understand and use $\log_a x - \log_a y = \log_a\left(\frac{x}{y}\right)$

☐ Understand and use $k\log_a x = \log_a x^k$

Understanding $\sin x$, $\cos x$, $\tan x$

☐ Understand and use the definitions of **sine**, **cosine** and **tangent**

☐ Understand and use the functions, graphs, symmetries, periodicity of **sin**, **cos** and **tan**

☐ Understand and use $\tan \theta = \frac{\sin \theta}{\cos \theta}$ and $\sin^2 \theta + \cos^2 \theta = 1$

Solving Mini-Trig Equations

☐ Solve simple trigonometric equations in a given interval

☐ Solve quadratic equations in **sin**, **cos** and **tan**

☐ Solve equations involving multiples of the unknown angle
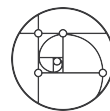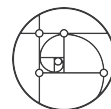
Introduction to Differentiation

☐ Differentiate x^n for rational values of n, and related constant multiples, sums, differences

☐ Use differentiation from first principles for small positive integer powers of x

☐ Sketch the gradient function of a curve

Tangents and Normals

☐ Understand the derivative of $f(x)$ $\left(\frac{dy}{dx}\right)$ is the gradient of the tangent to $y = f(x)$ at (x, y)

☐ Understand the second derivative $\left(\frac{d^2y}{dx^2}\right)$ is the rate of change of the gradient

☐ Use the second derivative to determine if a stationary point is a maximum or a minimum

☐ Apply differentiation to find gradients, tangents and normals

Stationary Points

☐ Understand that stationary points are maxima and minima

☐ Use stationary points when sketching graphs

☐ Use the derivative to identify where functions are increasing and decreasing

Introduction to Integration

☐ Know and use the Fundamental Theorem of Calculus

☐ Integrate x^n $(x \neq -1)$ and related sums, differences and constant multiples

☐ Use $f'(x)$ and a point on the curve to find the equation of a curve in the form $y = f(x)$

Area Under Curves

☐ Evaluate definite integrals to find the area under a curve


☐ Understand the implication of a negative answer
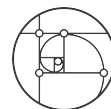
Proof

☐ Understand and use the structure of mathematical proof

☐ Be familiar with the logical connectives $\equiv$, $\Rightarrow$ and $\Leftrightarrow$

☐ Understand and use the terms integer, real, rational and irrational

☐ Use proof by deduction, e.g. differentiation from first principles

☐ Use proof by exhaustion; try all of the available options to prove/disprove statements

☐ Use disproof by counter example; find a value that doesn't work for the statement
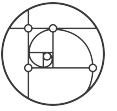
Sampling Techniques

☐ Understand and use the terms population and sample

☐ Use samples to make informed inferences about the population

☐ Understand simple random sampling, stratified sampling and systemic sampling

☐ Understand quota sampling and opportunity (or convenience) sampling

☐ Understand, select and critique sampling techniques in context
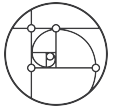
Comparing Data Sets

☐ Interpret the mean, median, mode, variance, standard deviation, range and IQR

☐ Use linear interpolation to calculate percentiles from grouped data

☐ Interpret frequency polygons, box and whisker plots and cumulative frequency diagrams

Histograms

☐ Interpret histograms, and understand the area under a histogram represents frequency

Quartiles & Interpolation

☐ Recognise and interpret possible outliers in data sets and statistical diagrams

☐ Use $Q_1 - 1.5 \times \text{IQR}$ and $Q_3 + 1.5 \times \text{IQR}$ or $\text{mean} \pm 3 \times \text{standard deviation}$

☐ Clean data by dealing with missing data, errors and outliers

Standard Deviation

☐ Calculate standard deviation, including from summary statistics
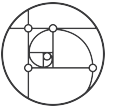
Correlation & Regression

☐ Understand the terms explanatory (independent) and response (dependent) variables

☐ Interpret scatter diagrams and regression lines for bivariate data

☐ Interpret scatter diagrams that include distinct sections of the population

☐ Use the terms positive, negative, zero, strong and weak to informally interpret correlation

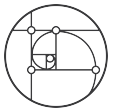☐ Understand that correlation does not imply causation
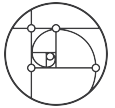
Venn Diagrams & Set Notation

☐ Use Venn diagrams and tree diagrams to represent probabilities

☐ Understand and calculate probabilities of mutually exclusive and independent events

☐ Link probabilities to discrete and continuous distributions

Binomial Probabilities

- [ ] Know and identify discrete uniform distributions

- [ ] Use the binomial distribution as a model to calculate probabilities

- [ ] Be familiar with the notation $X \sim \mathrm{B}(n, p)$

- [ ] Use a calculator to find individual or cumulative binomial probabilities

- [ ] Apply the binomial distribution to real-world situations and comment on its suitability
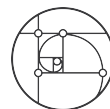
Hypothesis Test for Significance (Binomial)

☐ Use the terms null hypothesis, alternative hypothesis, significance level and test statistic.

☐ Use the terms 1-tail test, 2-tail test, critical value, critical and acceptance region, p-value

☐ Conduct a statistical hypothesis test for the proportion in the binomial distribution

☐ Interpret the results of a hypothesis test in context, while implying uncertainty

☐ Understand that a sample is used to make an inference about a population

☐ Appreciate that the significance level is the probability of incorrectly rejecting H_0
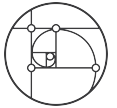
st, vt & at Graphs

☐ Understand and use position, displacement, distance, velocity, speed, acceleration

☐ Understand, use and interpret displacement-time graphs and velocity-time graphs

☐ Understand that the area under a velocity-time graph is equal to the distance travelled

☐ Understand that the gradient of a velocity-time graph is equal to the acceleration

Constant Acceleration Problems

☐ Understand, use and derive formulae for constant acceleration for straight line motion
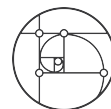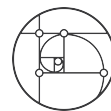
1D Variable Acceleration

Use calculus in kinematics for motion in a straight line

$$v = \frac{\mathrm{d}r}{\mathrm{d}t}, \qquad a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 r}{\mathrm{d}t^2}, \qquad r = \int v \ \mathrm{d}t, \qquad v = \int a \ \mathrm{d}t$$

Tailored Tutors

Forces & Newton's Laws

☐ Understand the concept of a force

☐ Understand and use Newton's first law

☐ Understand and use Newton's second law for straight line motion, constant acceleration

☐ Understand and use Newton's third law for straight line motion

☐ Understand and use Newton's third law for equilibrium of forces on a particle

☐ Apply Newton's third law to smooth pulleys and connected particles

☐ Understand and use weight and motion in a straight line under gravity (g)

☐ Understand and use the concept of a normal reaction force (R)

☐ Know that, when contact between an object and a surface is lost, $R = 0$

☐ Understand the concept of a frictional force and apply it when the force is given

Vectors - Force Problems

☐ Understand and use Newton's second law for forces given as 2D vectors

☐ Understand and use Newton's third law for simple cases of equilibrium with vectors