Year 12 Pure Maths

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| **Binomial expansion and Completing Square** Understand and use the binomial expansion of $(a + bx)^{n}$ where n is a positive integer.Know the notations n! and nCr and that nCr is the number of ways of selecting r distinct objects from n.Quadratic graphs: completing the square; factorising; symmetry |
| **Proof**Understand and be able to use the structure of mathematical proof. Use methods of proof, including proof by deduction and proof by exhaustion. Be able to disprove a conjecture by the use of a counter example.  |
| **Algebra and Solutions of Equations**Know and be able to use vocabulary and notation appropriate to the subject at this level.Know and be able to use vocabulary and notation appropriate to the subject at this level.Be able to change the subject of a formula.Be able to solve quadratic equations.Be able to find the discriminant of a quadratic function and understand its significance.Be able to solve linear simultaneous equations in two unknowns.Be able to solve simultaneous equations in two unknowns with one equation linear and one quadratic.Know the significance of points of intersection of two graphs with relation to the solution of equations. |
| **Inequalities**Be able to solve linear inequalities in one variable.Be able to represent and interpret linear inequalities graphically e.g. $y > x + 1.$Be able to solve quadratic inequalities in one variable. Be able to represent and interpret quadratic inequalities graphically e.g. $y > ax^{2} + bx + c.$Be able to express solutions of inequalities through correct use of ‘and’ and ‘or’, or by using set notation. |
| **Surds and Indices**Be able to use and manipulate surds.Be able to rationalise the denominator of a surd.Understand and be able to use the laws of indices for all rational exponents.Understand and be able to use negative, fractional and zero indices.Understand and use proportional relationships and their graphs. |
| **Polynomials**Be able to add, subtract, multiply and divide polynomials.Understand the factor theorem and be able to use it to factorise a polynomial or to determine its zeros. |
| **Graphs**Understand and use graphs of functions.Understand how to find intersection points of a curve with coordinate axes.Understand and be able to use the method of completing the square to find the line of symmetry and turning point of the graph of a quadratic function and to sketch a quadratic curve (parabola).Be able to sketch and interpret the graphs of simple functions including polynomials.Be able to use stationary points when curve sketching.Be able to sketch and interpret the graphs of $y=\frac{a}{x}$ and $y=\frac{a}{x^{2}}$Be able to sketch curves of the forms $y =af(x),$ $y =f(x) + a, y =f(x + a)$ and $y =f(ax),$ given the curve of $y =f(x)$ and describe the associated transformations.Be able to form the equation of a graph following a single transformation. |
| **Coordinate Geometry**Understand and use the equation $y =mx + c.$Know and be able to use the relationship between the gradients of parallel lines and perpendicular lines.Be able to calculate the distance between two points.Be able to find the coordinates of the midpoint of a line segment joining two points.Be able to form the equation of a straight line.Be able to draw a line given its equation.Be able to find the point of intersection of two lines.Be able to use straight line models.Be able to find the point(s) of intersection of a line and a curve or of two curves.Be able to find the point(s) of intersection of a line and a circle.Understand and use the equation of a circle in the form $(x - a)^{2} + (y - b)^{2} = r^{2}$Know and be able to use the following properties:• the angle in a semicircle is a right angle;• the perpendicular from the centre of a circle to a chord bisects the chord;• the radius of a circle at a given point on its circumference is perpendicular to the tangent to the circle at that point. |
| **Trigonometry**Be able to use the definitions of $sin x, cos x$ and $tan x$ for any angle.Know and use the graphs of $sin x, cos x$ and $tan x$ for all values of x, their symmetries and periodicities.Know and be able to use the exact values of $sin x $and $cos x$ for x = 0°, 30°, 45°, 60° and 90° and the exact values of $tan x$ for x = 0°, 30°, 45° and 60°.Know and be able to use the fact that the area of a triangle is given by $\frac{1}{2}ab sinC.$Know and be able to use the sine and cosine rules.Understand and be able to use $\tan(x≡\frac{\sin(x)}{\cos(x)})$Understand and be able to use the identity$ sin^{2}x+cos^{2}x≡1$Be able to solve simple trigonometric equations in given intervals and know the principal values from the inverse trigonometric functions. |
| **Exponentials and Logarithms**Be able to convert from an index to a logarithmic form and vice versa.Understand a logarithm as the inverse of the appropriate exponential function and be able to sketch the graphs of exponential and logarithmic functions.Understand the laws of logarithms and be able to apply them, including to taking logarithms of both sides of an equation.Know and use the values of log a and log 1.Be able to solve an equation of the form $a ^{x}$= b.Know how to reduce the equations$ y = ax^{n}$ and $y = ab^{x}$ to linear form and, using experimental data, to use a graph to estimate values of the parameters.Know and be able to use the function $y = e^{x}$ and its graph.Know that the gradient of $e^{kx}$ is $ke^{kx}$ and hence understand why the exponential model is suitable in many applications.Know and be able to use the function $y = ln x$ and its graph. Know the relationship between $ln x$ and $e^{x}$.Be able to solve problems involving exponential growth and decay; be able to consider limitations and refinements of exponential growth and decay models. |
| **Differentiation**Know and use that the gradient of a curve at a point is given by the gradient of the tangent at the point.Know and use that the gradient of the tangent at a point A on a curve is given by the limit of the gradient of chord AP as P approaches A along the curve.Understand and use the derivative of $f(x)$ as the gradient of the tangent to the graph of $y = f(x)$ at a general point $(x, y).$ Know that the gradient function$ \frac{dy}{dx} $ gives the gradient of the curve and measures the rate of change of y with respect to x.Be able to sketch the gradient function for a given curve.Be able to differentiate $y = kx^{n}$ where $k$ is a constant and $n$ is rational, including related sums and differences.Understand and use the second derivative as the rate of change of gradient.Be able to use differentiation to find stationary points on a curve: maxima and minima.Understand the terms increasing function and decreasing function and be able to find where the function is increasing or decreasing.Be able to find the equation of the tangent and normal at a point on a curve. |
| **Integration**Know that integration is the reverse of differentiationBe able to integrate functions of the form $kx^{n}$ where $k$ is a constant and $n\ne $-1.Be able to find a constant of integration given relevant information.Know what is meant by indefinite and definite integrals.Be able to evaluate definite integrals.Be able to use integration to find the area between a graph and the x-axis. |
| **Vectors**Understand the language of vectors in two dimensions.Be able to add and subtract vectors using a diagram or algebraically, multiply a vector by a scalar, and express a vector as a combination of others.Be able to calculate the magnitude and direction of a vector and convert between component form and magnitude-direction form.Understand and use position vectors.Be able to calculate the distance between two points represented by position vectors.Be able to use vectors to solve problems in pure mathematics and in context, including problems involving forces. |

Year 12 Mechanics

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| **Modelling**Know the language used to describe simplifying assumptions in mechanics. Understand and use the particle model. Understand and use fundamental quantities and units in the S.I. system: length, time, mass. Understand and use derived quantities and units: velocity, acceleration, force, weight.  |
| **Kinematics**Understand and use the language of kinematics. Know the difference between position, displacement, distance and distance travelled. Know the difference between velocity and speed, and between acceleration and magnitude of acceleration. Be able to draw and interpret kinematics graphs for motion in a straight line, knowing the significance (where appropriate) of their gradients and the areas underneath them. Be able to differentiate position and velocity with respect to time and know what measures result.Be able to integrate acceleration and velocity with respect to time and know what measures result. Be able to recognise when the use of constant acceleration formulae is appropriate. Be able to solve kinematics problems using constant acceleration formulae and calculus for motion in a straight line. |
| **Forces**Understand the language relating to forces. Know that the acceleration due to gravity is not a universal constant but depends on location in the universe. Know that on earth, the acceleration due to gravity is often modelled to be a constant, *g*  $ms^{-2}$Be able to identify the forces acting on a system and represent them in a force diagram. Understand the difference between external and internal forces and be able to identify the forces acting on part of the system. Be able to find the resultant of several concurrent forces when the forces are parallel or in two perpendicular directions or in simple cases of forces given as 2-D vectors in component form. Understand the concept of equilibrium and know that a particle is in equilibrium if and only if the vector sum of the forces acting on it is zero in the cases where the forces are parallel or in two perpendicular directions or in simple cases of forces given as 2-D vectors in component form.  |
| **Newton’s Laws of Motion**Know and understand the meaning of Newton’s three laws. Understand the term equation of motion. Be able to formulate the equation of motion for a particle moving in a straight line when the forces acting are parallel or in two perpendicular directions or in simple cases of forces given as 2-D vectors in component form. Be able to model a system as a set of connected particles. Be able to formulate the equations of motion for the individual particles within the system. Know that a system in which none of its components have any relative motion may be modelled as a single particle with the mass of the system.  |

Year 12 Statistics

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| **Data Collection**Understand and use the terms population and sample.Be able to use samples to make informal inferences about a population, recognising that different samples might lead to different conclusions.Understand and be able to use the concept of random sampling.Understand and be able to use a variety of sampling techniques.Be able to select or evaluate sampling techniques in the context of solving a statistical problem. |
| **Data Processing, Presenting and Interpretation**Be able to recognise and work with categorical, discrete, continuous and ranked data. Be able to interpret standard diagrams for grouped and ungrouped single-variable data.Understand that the area of each bar in a histogram is proportional to frequency. Be able to calculate proportions from a histogram and understand them in terms of estimated probabilities.Be able to interpret a cumulative frequency diagram.Be able to describe frequency distributions.Understand that diagrams representing unbiased samples become more representative of theoretical probability distributions with increasing sample size.Be able to interpret a scatter diagram for bivariate data, interpret a regression line or other best fit model, including interpolation and extrapolation, understanding that extrapolation might not be justified.Be able to recognise when a scatter diagram appears to show distinct sections in the population. Be able to recognise and comment on outliers in a scatter diagram.Be able to recognise and describe correlation in a scatter diagram and understand that correlation does not imply causation.Be able to select or critique data presentation techniques in the context of a statistical problem.Know the standard measures of central tendency and be able to calculate and interpret them and to decide when it is most appropriate to use one of them.Know simple measures of spread and be able to use and interpret them appropriately.Know how to calculate and interpret variance and standard deviation for raw data, frequency distributions, grouped frequency distributions.Be able to use the statistical functions of a calculator to find mean and standard deviation.Understand the term outlier and be able to identify outliers. Know that the term outlier can be applied to an item of data which is: at least 2 standard deviations from the mean OR at least 1.5 × IQR beyond the nearer quartile.Be able to clean data including dealing with missing data, errors and outliers. |
| **Probability**Be able to calculate the probability of an event.Understand the concept of a complementary event and know that the probability of an event may be found by means of finding that of its complementary event.Be able to calculate the expected frequency of an event given its probability.Be able to use appropriate diagrams to assist in the calculation of probabilities.Understand and use mutually exclusive events and independent events.Know to add probabilities for mutually exclusive events.Know to multiply probabilities for independent events. |
| **Binomial Distribution**Recognise situations which give rise to a binomial distribution.Be able to identify the probability of success, p, for the binomial distribution.Be able to calculate probabilities using the binomial distribution.Understand and use mean = np.Be able to calculate expected frequencies associated with the binomial distribution.Be able to use probability functions, given algebraically or in tables.Know the term discrete random variable.Be able to calculate the numerical probabilities for a simple distribution.Understand the term discrete uniform distribution. |
| **Hypothesis Testing**Understand the process of hypothesis testing and the associated language.Understand when to apply 1- tail and 2- tail tests.Understand that a sample is being used to make an inference about the population and appreciate that the significance level is the probability of incorrectly rejecting the null hypothesis.Be able to identify null and alternative hypotheses (H0 and H1) when setting up a hypothesis test based on a binomial probability model.Be able to conduct a hypothesis test at a given level of significance. Be able to draw a correct conclusion from the results of a hypothesis test based on a binomial probability model and interpret the results in context.Be able to identify the critical and acceptance regions. |