Belfairs Academy

Mathematics Fundamentals Year 12 – Pure Mathematics

Knowledge	Skills
Algebra and Functions	
• Understand and use the laws of indices for all rational exponents • Work with quadratic functions and their graphs • The discriminant of a quadratic function, including the conditions for real and repeated roots • Completing the square • Solution of quadratic equations, including solving quadratic equations in a function of the unknown • Express solutions through correct use of 'and' and 'or', or through set notation • Represent linear and quadratic inequalities such as $y > x + 1$ and $y > ax^2 + bx + c$ graphically • Understand and use graphs of functions; sketch curves defined by simple equations including polynomials, $y = \frac{a}{x}$ and $y = \frac{a}{x^2}$ (including their vertical and horizontal asymptotes) • Interpret algebraic solution of equations graphically; use intersection points of graphs to solve equations • Understand the effect of simple transformations on the graph of $y = f(x)$ including sketching associated graphs: • $y = af(x)$, $y = f(x) + a$, $y = f(x + a)$, $y = f(ax)$	• Use and manipulate surds, including rationalising the denominator • Solve simultaneous equations in two variables by elimination and by substitution, including one linear and one quadratic equation • Solve linear and quadratic inequalities in a single variable and interpret such inequalities graphically, including inequalities with brackets and fractions • Manipulate polynomials algebraically, including expanding brackets, collecting like terms and factorisation and simple algebraic division; use of the factor theorem

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Knowledge	Skills
Coordinate Geometry in the (x,y) Plane	

• Understand and use proportional relationships and their graphs
• Understand and use the equation of a straight line, including the forms $y - y_1 = m(x - x_1)$ and $ax + by + c = 0$
• Gradient conditions for two straight lines to be parallel or perpendicular
• Understand and use the coordinate geometry of the circle including using the equation of a circle in the form$(x - a)^2 + (y - b)^2 = r^2$
• Use of the following properties:
  • the angle in a semicircle is a right angle
  • the perpendicular from the centre 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
	• Be able to use straight line models in a variety of contexts
	• Completing the square to find the centre and radius of a circle

Knowledge	Skills
Further Algebra	
• Understand and use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion; use methods of proof, including: proof by deduction, proof by exhaustion, disproof by counter-example • Understand and use the binomial expansion of $(a + bx)^n$ for positive integer *n*; the notations *n*! and $_nC_r$; link to binomial probabilities	• Manipulate polynomials algebraically, including expanding brackets and collecting like terms, factorisation and simple algebraic division; use of the factor theorem

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Knowledge	Skills
Trigonometry	
• Understand and use the definitions of sine, cosine and tangent for all arguments; the sine and cosine rules; the area of a triangle in the form $\frac{1}{2}ab\sin C$ • Understand and use the sine, cosine and tangent functions; their graphs, symmetries and periodicity • Understand and use $\tan\theta = \frac{\sin\theta}{\cos\theta}$ • Understand and use $\sin^2\theta + \cos^2\theta = 1$	• Solve simple trigonometric equations in a given interval, including quadratic equations in sin, cos and tan and equations involving multiples of the unknown angle

Knowledge	Skills
Vectors (2D)	
• Use vectors in two dimensions • Understand and use position vectors; calculate the distance between two points represented by position vectors • Use vectors to solve problems in pure mathematics and in context, (including forces)	• Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form • Add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations

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Knowledge	Skills
Differentiation	
• 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*); the gradient of the tangent as a limit; interpretation as a rate of change • Second derivatives • Identify where functions are increasing or decreasing	• Sketching the gradient function for a given curve • Differentiation from first principles for small positive integer powers of x • Differentiate x^n, for rational values of *n*, and related constant multiples, sums and differences • Apply differentiation to find gradients, tangents and normals, maxima and minima and stationary points

Knowledge	Skills
Integration	
• Know and use the Fundamental Theorem of Calculus	• Integrate x^n (excluding *n* = −1), and related sums, differences and constant multiples • Evaluate definite integrals; use a definite integral to find the area under a curve

Knowledge	Skills
Exponentials and Logarithms	
• Know and use the function a^x and its graph, where *a* is positive • Know and use the function e^x and its graph	• Solve equations of the form $a^x = b$ • Use logarithmic graphs to estimate parameters in relationships of the form $y = ax^n$ and $y = kb^x$, given data for x and *y*

• Know that the gradient of e^{kx} is equal to ke^{kx} and hence understand why the exponential model is suitable in many applications • Know and use the definition of $\log_a x$ as the inverse of a^x, where a is positive and $x \geq 0$ • Know and use the function $\ln x$ and its graph • Know and use ln x as the inverse function of e^x • Understand and use the laws of logarithms: $\log_a x + \log_a y = \log_a(xy)$ $\log_a x - \log_a y = \log_a\left(\frac{x}{y}\right)$ $k\log_a x = \log_a x^k$ (including, for example, $k = -1$ and $= -\frac{1}{2}$)	• Understand and use exponential growth and decay; use in modelling (examples may include the use of e in continuous compound interest, radioactive decay, drug concentration decay, exponential growth as a model for population growth); consideration of limitations and refinements of exponential models