Scheme of Work.   Additional Mathematics

1. **Coordinate Geometry**	
Distance between two points.	Length of hypotenuse = $\sqrt{(y - y_1)^2 + (x - x_1)^2}$ *Sketch points, label fully y and x distances*
Gradient of the straight line joining two points.	Gradient = $\frac{y - y_1}{x - x_1}$ *Sketch points, label fully y and x distances*
Equations of a Straight Line	Equations of a Straight Line 1. $y = mx + c$ 2. $ax + by + c = 0$ *rearrange equation* 3. $y - y_1 = m(x - x_1)$ *Use of the fact that m is the gradient and c is the intercept on the y-axis.*
Equations of lines parallel and perpendicular to a given line.	(*Use of the fact that parallel lines have equal gradients and the product of the gradients of two perpendicular lines is – 1.*)
Intersection of a straight line with a curve.	*The coordinates of the points of intersection of a curve of the form* $ax^2 + by^2 + cxy + dx + ey + f = 0$ *with a line of the form* $px+qy+r = 0$
2a. Algebra	
Simplify numerical expressions involving surds.	Simplification of expressions involving surds. $(\sqrt{3} + \sqrt{2})^2 - (\sqrt{3} - \sqrt{2})^2 = 4\sqrt{6}$ Including the rationalisation of the denominator of an expression such as $\frac{1}{(2-\sqrt{3})}$
Understand and use indices with negative and fractional values.	*Find the values of* $8^{2/3}$ $16^{-1/2}$ $7^0 \times 16^{3/4}$ Simplify $(y^{2/3} \times y^{1/2} \times y^{5/6})^{1/2}$ $\frac{5x^{1/2} + 6x^{3/2}}{7x^{1/2}}$
2b. Algebra	
Factorisation of quadratic expressions.	Factorisation of quadratic expressions of the form $ax^2 + bx + c$, $a \neq 1$. Factorise (i) $3x^2 - 48$ Difference of two Squares (ii) $3m^2 - 10m + 3$ (iii) $12d^2 + 5d - 2$. The solution by factorisation of quadratic equations of the form $ax^2 + bx + c = 0$, $a \neq 1$. A rectangle has longer side (2x + 3) m and shorter side (x + 1) m. Its area is 66 m^2. Write down a quadratic equation which is satisfied by x and arrange it in the form $ax^2 + bx + c = 0$ where a, b and c are integers.

Completing the square.	Deriving roots of general quadratic equations. *Show that the roots of the quadratic equation* *$ax^2 + bx + c = 0$ are* $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Solving quadratic equations by completing the square. *Use the method of completing the square to solve* *$x^2 + 5x - 3 = 0$. Express your solutions in surd form.* *By completing the square find the minimum value of* *$x^2 - 16x + 61$.*

3. Mensuration

Measurement including distances and angles, to more complex plane shapes and solids, including circular arcs, cylinders, cones and spheres.	Volumes and surface areas of spheres, cones and pyramids. Lengths of circular arcs. Areas of sectors and segments of circles.

4. Trigonometry

Trigonometric ratios of angles up to four right-angles.	The application and understanding of the sine, cosine and tangent of angles between $0°$ and $360°$.
Special values for $0°$, $30°$, $45°$ and their multiples	Use of the special values of sine, cosine and tangent of $0°$, $30°$ and $45°$ and their multiples.
Simple problems in three-dimensions.	The application of Pythagoras' theorem, the trigonometry of right-angled triangles, the sine rule and the cosine rule to problems in three-dimensions

5. Calculus

Differentiation Given $y = f(x)$ find $\frac{dy}{dx}$ from first principles in simple cases	f(x) will be linear or quadratic.
Differentiation of x_n and related sums and differences.	Use of $\frac{d(x^n)}{dx} = nx^{n-1}$ *Differentiate* $f(x) = 2x^8$, $f(x) = \frac{3}{4x^2}$ $f(x) = x^{\frac{1}{2}}$, $f(x) = 3x^{-\frac{1}{2}}$ $f(x) = (x-3)^2$, $f(x) = 4x^3 - 2x + 3$, $f(x) = 2x^{\frac{1}{2}} - x^{-\frac{1}{2}}$
Second derivatives in simple cases.	*Given $y = x_3 + 3x_2 + 1$ find* $\frac{d^2y}{dx^2}$
Equations of tangents.	*Find the equation of the tangent to the curve $y = x_2$ at the point (2,4)*
Maximum and minimum values. (Consideration of points of inflexion will not be assessed.)	Understand that $\frac{dy}{dx} = 0$ at maximum and minimum points on a curve. *Find the maximum and minimum points on the curve $y = x^3 + 3x^2 + 1$ and determine their nature. Hence sketch the curve.*

Integration as the reverse of differentiation.	Given that $\frac{dy}{dx} = x^n$ then *y* = $y = \frac{x^{n+1}}{n+1} + c$ (*n* ≠ *-1*)
Indefinite integrals as the reverse of differentiation. Evaluation of definite integrals. Applications to simple areas, where the curve is entirely above or below the *x*-axis in the given interval.	$\int \frac{1}{x^2} dx \quad \int 8\sqrt{x} dx \quad \int (3x^2 + 5x - 2) dx \quad \int \left(1 - \frac{2}{x^2}\right) dx$ $\int_0^3 8\sqrt{x} dx \quad \int_1^2 x^3 + 4 dx$ The required area will be enclosed between the curve and lines drawn parallel to either the *x*- or *y*- axis. *Find the area under the curve* $y = x_2$ *between* *x = 1 and x = 2.* *Find the area between the curve* $y = x_2 + 6x$ *and the x-axis for values of x from – 3 to 0.*

6. Algebra

Algebraic Expressions and Equations	Simplify algebraic expressions involving fractions. Solution of algebraic equations involving fractions.
Algebraic proof	Algebraic identities. Use of the symbol ≡ *Show that* $(3x - 1)(3x + 1) - (1 - x)(1 + x) + 3(1 - 2x)(1 + 2x) \equiv 1 - 2x^2$ *Show that* $(x - 1)(x^2 + 2x + 3) - x(x + 1) \equiv x^3 - 3$ *Prove that the sum of any three consecutive numbers is divisible by* 3.
Remainder Theorem and Factor Theorem	*Find the remainder when* $2x^3 + x - 5$ *is divided by* $2x - 1$. *Show that* $x - 1$ *is a factor of* $x^3 - 7x + 6$. *When* $x^3 + 2x^2 + a$ *is divided by* $x - 2$ *the remainder is – 3. Find a.* Factorise polynomials of at most degree three. *Show that* $x - 1$ *is a factor of* $2x^3 - x^2 - 2x + 1$*, and hence factorise the expression.*
Solution of one linear and one quadratic equation.	Solution of equations of the form $ax^2 + by^2 + cxy + dx + ey + f = 0$ and $px + qy + r = 0$, where some of the coefficients may be zero.

7. Trigonometry

The graphs and behaviour of trigonometric functions, and the application of these to the solution of simple equations.	Sketching trigonometric graphs of the form $y = a \sin k\theta$, $y = b \cos k\theta$ and $y = c \tan k\theta$. Solutions of equations of the form $a \sin k\theta = b$, $a \cos k\theta = b$, $a \tan k\theta = b$. *Find the solutions of the equation* $2 \cos 3\theta = -1$ *in the range* $0° \le x \le 180°$