1.	Number—Extended curriculum	Notes / Examples
1.1	Knowledge of: natural numbers, integers (positive, negative, and zero), prime numbers, square numbers, rational and irrational numbers, real numbers. Use of symbols: $=, \neq, \leqslant, \geqslant, <, >$	Understand that the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a non-zero rational number and an irrational number is irrational.
1.2	Use of the four operations and parentheses.	Applies to integers, fractions, and decimals. Choose mental or written methods appropriate to the number or context.
1.3	Multiples and factors, including greatest common factor, least common multiple.	GCF and LCM will be used and knowledge of prime factors is assumed.
1.4	Ratio and proportion.	
1.5	Understand and use the language and notation of fractions, decimals, and percentages; recognize equivalences between decimals, fractions, ratios, and percentages and convert between them. Order quantities given in different forms by magnitude, by first converting into same form.	
1.6	Percentages, including applications such as interest and profit.	Includes reverse percentages. Includes both simple and compound interest. Includes percentiles.
1.7	Meaning and calculation of exponents (powers, indices) including positive, negative, zero and fractional exponents. Explain the definition of radical exponents as an extension to integral exponents. Explain the rules for exponents. Scientific notation (Standard Form) $a \times 10^n$ where $1 \leqslant a < 10$ and n is an integer.	e.g., $5^{\frac{1}{2}} = \sqrt{5}$ Evaluate 5^{-2}, $100^{\frac{1}{2}}$, $8^{-\frac{2}{3}}$ Work out $2^4 \times 2^{-3}$ Convert numbers in and out of scientific notation. Calculate with values in scientific notation.

1.	Number—Extended curriculum	Notes / Examples
1.8	Radicals, calculation and simplification of square root and cube root expressions.	e.g., simplify $\sqrt{200} + \sqrt{18}$ Write $(2 + \sqrt{3})^2$ in the form $a + b\sqrt{3}$
1.9	Use units to understand problems and guide the solution to multi-step problems. Quantities—choose and interpret units and scales, define appropriate quantities (including money). Estimating, rounding, decimal places, and significant figures—choose a level of accuracy appropriate for a problem.	Also relates to graphs and geometrical measurement topics. Includes converting between units, e.g., different currencies. Use estimation to check answers and consider whether the answer is reasonable in the context of the problem.
1.10	Calculations involving time: seconds (s), minutes (min), hours (h), days, months, years including the relation between consecutive units.	1 year = 365 days. Includes familiarity with both 24-hour and 12-hour clocks and extraction of data from dials and schedules.
1.11	Speed, distance, time problems.	

2.	Algebra—Extended curriculum	Notes / Examples
2.1	Writing, showing, and interpretation of inequalities on the real number line.	
2.2	Create and solve linear inequalities.	e.g., Solve $3x + 5 < 7$ Solve $-7 \leqslant 3n - 1 < 5$
2.3	Create expressions and create and solve linear equations, including those with fractional expressions.	Explain each algebraic step of the solution. May be asked to interpret solutions to a problem given in context. Construct a viable argument to justify a solution method.
2.4	Exponents (indices).	Includes rules of indices with negative and fractional indices. e.g., simplify $2x^{\frac{3}{2}} \times 5x^{-4}$
2.5	Rearrangement and evaluation of formulae.	Includes manipulation of algebraic expressions to prove identities. Formulae may include indices or cases where the subject appears twice. e.g., make r the subject of • $V = \frac{4}{3}\pi r^3$ • $p = \dfrac{2r - 3}{r + s}$ e.g., $y = m^2 - 4n^2$ Find the value of y when $m = 4.4$ and $n = 2.8$
2.6	Create and solve simultaneous linear equations in two variables algebraically and graphically.	*See functions 3.2*
2.7	Identify terms, factors, and coefficients. Interpret algebraic expressions in terms of a context.	e.g., interpret $P(1 + r)^n$ as the product of P and a factor not depending on P.
2.8	Expansion of parentheses, including the square of a binomial. Simplify expressions.	e.g., expand $(2x - 5)^2 = 4x^2 - 20x + 25$

2.	Algebra—Extended curriculum	Notes / Examples
2.9	Use equivalent forms of an expression or function to reveal and explain properties of the quantities or function represented. Factorization: common factor difference of squares trinomial four term.	 $6x^2 + 9x = 3x(2x + 3)$ $9x^2 - 16y^2 = (3x - 4y)(3x + 4y)$ $6x^2 + 11x - 10 = (3x - 2)(2x + 5)$ $xy - 3x + 2y - 6 = (x + 2)(y - 3)$ Use the structure of an expression to identify ways to rewrite it, for example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.
2.10	Algebraic fractions: simplification, including use of factorization addition or subtraction of fractions with linear denominators multiplication or division and simplification of two fractions.	e.g., simplify $\frac{4x^2 - 9}{8x^2 - 10x - 3}$, $\frac{3}{2x+1} - \frac{4}{x}$, $\frac{7x}{4y^2} \div \frac{21x}{8}$
2.11	Create and solve quadratic equations by: inspection factorization using the quadratic formula completing the square.	 e.g., $x^2 = 49$ $2x^2 + 5x - 3 = 0$ $3x^2 - 2x - 7 = 0$ Write $x^2 - 6x + 9$ in the form $(x - a)^2 + b$ and state the minimum value of the function. Quadratic formula will be given.
2.12	Solve simple rational and radical equations in one variable and discount any extraneous solutions.	e.g., solve $\sqrt{x} + 2 = 6$, $x^{-3} = 27$, $2y^4 = 32$
2.13	Continuation of a sequence of numbers or patterns; recognize patterns in sequences; generalize to simple algebraic statements, including determination of the n^{th} term. Derive the formula for the sum of a finite geometric series, and use the formula to solve problems.	e.g., find the n^{th} term of: • 5 9 13 17 21 • 2 4 8 16 32 • 2 5 10 17 26 • 3 6 12 24 48 For a common ratio that is not 1. e.g., calculate mortgage payments.
2.14	Express direct and inverse variation in algebraic terms and use this form of expression to find unknown quantities.	e.g., $y \propto x$, $y \propto \sqrt{x}$ $y \propto \frac{1}{x}$, $y \propto \frac{1}{x^2}$

3.	Functions—Extended curriculum	Notes / Examples
3.1	Use function notation. Knowledge of domain and range. Mapping diagrams.	e.g., f(x); f:x Understand that a function assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain then f(x) denotes the output of f corresponding to the input of x.
3.2	Understand and explain that the graph of an equation in two variables is the set of all its solutions plotted in the co-ordinate plane. Construct tables of values and construct graphs of functions of the form ax^n where a is a rational constant and $n = -2, -1, 0, 1, 2, 3$ and simple sums of not more than three of these and for functions of the type a^x where a is a positive integer. Solve associated equations approximately by graphical methods.	
3.3	Write a function that describes a relationship between two quantities.	e.g., C(x) = 50,000 + 400x models the cost of producing x wheelchairs. Write a function that represents the cost of one wheelchair.
3.4	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).	e.g., given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.
3.5	Recognition of the following function types from the shape of their graphs: linear $f(x) = ax + b$ quadratic $f(x) = ax^2 + bx + c$ cubic $f(x) = ax^3 + bx^2 + cx + d$ reciprocal $f(x)= \frac{a}{x}$ exponential $f(x) = a^x$ with $0 < a < 1$ or $a > 1$ trigonometric $f(x) = a\sin(bx)$; $a\cos(bx)$; $\tan x$ Interpret the key features of the graphs—to include intercepts; intervals where the function is increasing, decreasing, positive, negative; relative maxima and minima; symmetries; end behavior and periodicity.	Some of a, b, c, and d may be 0 Including period and amplitude.

<table>
<tr><th>3.</th><th>Functions—Extended curriculum</th><th>Notes / Examples</th></tr>
<tr><td>3.6</td><td>Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.</td><td>e.g., if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.</td></tr>
<tr><td>3.7</td><td>Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
Estimate the rate of change from a graph.</td><td>e.g., average speed between 2 points

e.g., use a tangent to the curve to find the slope</td></tr>
<tr><td>3.8</td><td>Behavior of linear, quadratic, and exponential functions:
linear $f(x) = ax + b$
quadratic $f(x) = ax^2 + bx + c$
exponential $f(x) = a^x$ with $0 < a < 1$ or $a > 1$</td><td>Observe, using graphs and tables, that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
Use the properties of exponents to interpret expressions for exponential functions, e.g., identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.</td></tr>
<tr><td>3.9</td><td>Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).</td><td>e.g., find the function or equation for the relationship between x and y
<table>
<tr><td>x</td><td>–2</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>y</td><td>3</td><td>5</td><td>7</td><td>9</td></tr>
</table></td></tr>
<tr><td>3.10</td><td>Simplification of formulae for composite functions such as $f(g(x))$ where $g(x)$ is a linear expression.</td><td>e.g., $f(x) = 6 + 2x$, $g(x) = 7x$,
$f(g(x)) = 6 + 2(7x) = 6 + 14x$</td></tr>
<tr><td>3.11</td><td>Inverse function f^{-1}.</td><td>Find an inverse function.
Solve equation of form $f(x) = c$ for a simple function that has an inverse.
Read values of an inverse function from a graph or a table, given that the function has an inverse.</td></tr>
<tr><td>3.12</td><td>Description and identification, using the language of transformations, of the changes to the graph of $y = f(x)$ when $y = f(x) + k$, $y = k\,f(x)$, $y = f(x + k)$ for $f(x)$ given in section 3.5.</td><td>Where k is an integer.</td></tr>
</table>

3.	Functions—Extended curriculum	Notes / Examples
3.13	Graph the solutions to a linear inequality in two variables as a half-plane (region), excluding the boundary in the case of a strict inequality. Graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	e.g., identify the region bounded by the inequalities $y > 3$, $2x + y < 12$, $y \leqslant x$.

4.	Geometry—Extended curriculum	Notes / Examples
4.1	Vocabulary: Know precise definitions of acute, obtuse, right angle, reflex, equilateral, isosceles, congruent, similar, regular, pentagon, hexagon, octagon, rectangle, square, kite, rhombus, parallelogram, trapezoid, and simple solid figures.	
4.2	Definitions: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.	
4.3	Line and rotational symmetry in 2D and 3D.	e.g., know properties of triangles, quadrilaterals, and circles directly related to their symmetries. For example, given a rectangle, parallelogram, trapezoid or regular polygon, describe the rotations and reflections that carry it onto itself. Recognize symmetry properties of the prism and the pyramid.
4.4	Angles around a point. Angles on a straight line and intersecting straight lines. Vertically opposite angles. Alternate and corresponding angles on parallel lines. Angle properties of triangles, quadrilaterals, and polygons. Interior and exterior angles of a polygon.	Formal proof is not required, but candidates will be expected to use reasoned arguments, including justifications, to establish geometric results from given information.

4.	Geometry—Extended curriculum	Notes / Examples
4.5	Construction. Make formal geometric constructions with compass and straight edge only. Copy a segment; copy an angle; bisect a segment; bisect an angle; construct perpendicular lines, including the perpendicular bisector of a line segment. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. Construct the inscribed and circumscribed circles of a triangle. Construct a tangent line from a point outside a given circle to the circle. Angle measurement in degrees. Read and make scale drawings.	
4.6	Vocabulary of circles. Properties of circles: • tangent perpendicular to radius at the point of contact • tangents from a point • angle in a semicircle • angles at the center and at the circumference on the same arc • cyclic quadrilateral Use the following symmetry properties of a circle: • equal chords are equidistant from the center • the perpendicular bisector of a chord passes through the center • tangents from an external point are equal in length	Formal proof is not required but candidates will be expected to use reasoned arguments, including justifications, to establish geometric results from given information.
4.7	Similarity. Calculation of lengths of similar figures. Area and volume scale factors.	Use scale factors and/or angles to check for similarity. Use of the relationships between areas of similar figures and extension to volumes and surface areas of similar solids.
4.8	Congruence. Recognise that two shapes are congruent and use this to solve problems.	

5.	Transformations and vectors—Extended curriculum	Notes / Examples
5.1	Vector notation: **a**; directed line segment $\overrightarrow{AB}$; component form $\begin{pmatrix} x \\ y \end{pmatrix}$ use appropriate symbols for vectors and their magnitudes	e.g., **v**, |**v**|
5.2	Find the components of a vector by subtracting the co-ordinates of an initial point from the co-ordinates of a terminal point. Use position vectors.	See also section 5.6, translations using column vectors.
5.3	Calculate the magnitude of a vector $\begin{pmatrix} x \\ y \end{pmatrix}$ as $\sqrt{(x^2 + y^2)}$.	
5.4	Add and subtract vectors.	Both algebraic (component) and geometric (parallelogram rule) addition/subtraction. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. Understand vector subtraction **v** – **w** as **v** + (–**w**), where –**w** is the additive inverse of **w**, with the same magnitude as **w** and pointing in the opposite direction.
5.5	Multiply a vector by a scalar.	e.g., $\left\| 3\begin{pmatrix} -4 \\ 3 \end{pmatrix} \right\| = 3(5) = 15$ $c\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} cx \\ cy \end{pmatrix}$ If c|**v**| ≠ 0, the direction of c**v** is either along **v** (for c > 0) or against **v** (for c < 0).
5.6	Transformations on the cartesian plane: translation, reflection, rotation, enlargement (dilation), stretch. Description of a translation using column vectors.	Representing and describing transformations.
5.7	Inverse of a transformation.	
5.8	Combined transformations.	e.g., find the **single** transformation that can replace a rotation of 180° around the origin followed by a translation by vector $\begin{pmatrix} 4 \\ -2 \end{pmatrix}$.

6.	Geometrical measurement—Extended curriculum	Notes / Examples
6.1	Units: mm, cm, m, km mm^2, cm^2, m^2, ha, km^2 mm^3, cm^3, ml, cl, l, m^3 g, kg	All units will be metric; conversion between units expected. Units of time as given in section 1.10.
6.2	Perimeter and area of rectangle, triangle, and compound shapes derived from these. Area of trapezoid and parallelogram.	
6.3	Circumference and area of a circle. Arc length and area of sector.	 From sector angles in degrees only.
6.4	Surface area and volume of a prism and a pyramid (in particular, cuboid, cylinder, and cone). Surface area and volume of a sphere.	Formulae will be given for the lateral surface area of a cylinder and a cone, the surface area of a sphere, and the volume of a pyramid, a cone, and a sphere.
6.5	Areas and volumes of compound shapes.	Involving combinations of the shapes in section 6.4.
6.6	Use geometric shapes, their measures, and their properties to describe objects.	e.g., modeling a tree trunk or a human torso as a cylinder.
6.7	Identify the shapes of two-dimensional cross sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.	
6.8	Apply concepts of density based on area and volume in modelling situations.	e.g. persons per square mile, BTUs per cubic foot.
6.9	Apply geometric methods to solve design problems.	e.g., design an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios.

7.	Co-ordinate geometry—Extended curriculum	Notes / Examples
7.1	Plotting of points and reading from a graph in the cartesian plane.	
7.2	Distance between two points.	e.g., use co-ordinates to compute the perimeters of polygons and areas of triangles using the distance formula.
7.3	Midpoint of a line segment. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.	
7.4	Slope of a line segment.	
7.5	Interpret and obtain the equation of a straight line as $y = mx + b$. Interpret and obtain the equation of a straight line as $ax + by = d$ (a, b, and d are integers)	e.g., obtain the equation of a straight line graph given a pair of co-ordinates on the line.
7.6	Slope of parallel line. Find the equation of a line parallel to a given line that passes through a given point. Slope of perpendicular line. Find the equation of a line perpendicular to a given line that passes through a given point.	Understand and explain how the slopes of parallel and perpendicular lines are related.

8.	Trigonometry—Extended curriculum	Notes / Examples
8.1	Use trigonometric ratios and the Pythagorean Theorem to solve right-angled triangles in applied problems. Know the exact values for the trigonometric ratios of 0°, 30°, 45°, 60°, 90°.	Problems involving bearings may be included. Know angle of elevation and depression.
8.2	Extend sine and cosine values to angles between 0° and 360°. Explain and use the relationship between the sine and cosine of complementary angles. Graph and know the properties of trigonometric functions.	
8.3	Sine Rule.	Formula will be given. ASA, SSA (ambiguous case included where the angle is obtuse).
8.4	Cosine Rule.	Formula will be given. SAS, SSS.
8.5	Area of triangle.	Formula will be given.

9.	Probability—Extended curriculum	Notes / Examples
9.1	Probability P(*A*) as a fraction, decimal, or percentage. Significance of its value, including using probabilities to make fair decisions.	Includes an understanding that the probability of an event occurring = 1 – the probability of the event not occurring. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). The knowledge and use of set notation is not expected.
9.2	Relative frequency as an estimate of probability.	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation, e.g., a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?
9.3	Expected number of occurrences.	
9.4	Combining events: Apply the addition rule P(*A* or *B*) = P(*A*) + P(*B*) – P(*A* and *B*) Apply the multiplication rule P(*A* and *B*) = P(*A*) × P(*B*).	Understand that two events are independent if the probability of A and B occurring together is the product of their probabilities and use this characterization to determine if they are independent.
9.5	Possibility diagrams. Tree diagrams including successive selection with or without replacement.	

10.	Statistics—Extended curriculum	Notes / Examples
10.1	Reading and interpretation of graphs or tables of data.	Make inferences to support or cast doubt on initial conjectures; relate results and conclusions to the original question.
10.2	Discrete and continuous data.	
10.3	Compound bar chart, dot plots, line graph, pie chart, simple frequency distributions, scatter diagram.	
10.4	Mean, mode, median, and range from lists of discrete data. Mean, modal class, median, and range from grouped and continuous data.	The term *estimated mean* may be used in questions involving grouped continuous data.
10.5	Histograms with frequency density on the vertical axis.	Includes histograms with unequal class intervals.
10.6	Cumulative frequency table and curve and box plots. Median, quartiles, percentiles, and inter-quartile range.	
10.7	Use and interpret statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (inter-quartile range) of two or more different data sets.	
10.8	Understanding and description of correlation (positive, negative, or zero) with reference to a scatter diagram. Straight line of best fit (by eye) through the mean on a scatter diagram.	