**George Stephenson High School Secondary Scheme of Work: Year 9H (Higher)**

| Unit | Lessons | Key Progression Indicators<br>Knowledge, Understanding and Skills |
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| **Calculations, checking and rounding** | 9 | • Add, subtract, multiply and divide decimals, whole numbers including any number between 0 and 1;<br>• Put digits in the correct place in a decimal calculation and use one calculation to find the answer to another;<br>• Use the product rule for counting (i.e. if there are $m$ ways of doing one task and for each of these, there are $n$ ways of doing another task, then the total number of ways the two tasks can be done is $m \times n$ ways);<br>• Round numbers to the nearest 10, 100, 1000, the nearest integer, to a given number of decimal places and to a given number of significant figures;<br>• Estimate answers to one- or two-step calculations, including use of rounding numbers and formal estimation to 1 significant figure: mainly whole numbers and then decimals. |
| **Indices, roots, reciprocals and hierarchy of operations** | 9 | • Use index notation for integer powers of 10, including negative powers;<br>• Recognise powers of 2, 3, 4, 5;<br>• Use the square, cube and power keys on a calculator and estimate powers and roots of any given positive number, by considering the values it must lie between, e.g. the square root of 42 must be between 6 and 7;<br>• Find the value of calculations using indices including positive, fractional and negative indices;<br>• Recall that $n^0 = 1$ and $n^{-1} = \frac{1}{n}$ for positive integers $n$ as well as, $n^{\frac{1}{2}} = \sqrt{n}$ and $n^{\frac{1}{3}} = \sqrt[3]{n}$ for any positive number $n$;<br>• Understand that the inverse operation of raising a positive number to a power $n$ is raising the result of this operation to the power $\frac{1}{n}$;<br>• Use index laws to simplify and calculate the value of numerical expressions involving multiplication and division of integer powers, fractional and negative powers, and powers of a power;<br>• Solve problems using index laws;<br>• Use brackets and the hierarchy of operations up to and including with powers and roots inside the brackets, or raising brackets to powers or taking roots of brackets;<br>• Use an extended range of calculator functions, including +, -, ×, ÷, $x^2$, $\sqrt{x}$, memory, $x^y$, $x^{\frac{1}{y}}$, brackets;<br>• Use calculators for all calculations: positive and negative numbers, brackets, powers and roots, four operations. |

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| **Factors, multiples and primes** | 9 | • Identify factors, multiples and prime numbers;<br>• Find the prime factor decomposition of positive integers – write as a product using index notation;<br>• Find common factors and common multiples of two numbers;<br>• Find the LCM and HCF of two numbers, by listing, Venn diagrams and using prime factors – include finding LCM and HCF given the prime factorisation of two numbers;<br>• Solve problems using HCF and LCM, and prime numbers;<br>• Understand that the prime factor decomposition of a positive integer is unique, whichever factor pair you start with, and that every number can be written as a product of prime factors. |
| **Standard form and surds** | 9 | • Convert large and small numbers into standard form and vice versa;<br>• Add, subtract, multiply and divide numbers in standard form;<br>• Interpret a calculator display using standard form and know how to enter numbers in standard form;<br>• Understand surd notation, e.g. calculator gives answer to sq rt 8 as 4 rt 2;<br>• Simplify surd expressions involving squares (e.g. $\sqrt{12} = \sqrt{(4 \times 3)} = \sqrt{4} \times \sqrt{3} = 2\sqrt{3}$). |
| **Algebra: the basics** | 9 | • Use algebraic notation and symbols correctly;<br>• Know the difference between a term, expression, equation, formula and an identity;<br>• Write and manipulate an expression by collecting like terms;<br>• Substitute positive and negative numbers into expressions such as $3x + 4$ and $2x^3$ and then into expressions involving brackets and powers;<br>• Substitute numbers into formulae from mathematics and other subject using simple linear formulae, e.g. $l \times w$, $v = u + at$;<br>• Simplify expressions by cancelling, e.g. $\frac{4x}{2} = 2x$;<br>• Use instances of index laws for positive integer powers including when multiplying or dividing algebraic terms;<br>• Use instances of index laws, including use of zero, fractional and negative powers;<br>• Multiply a single term over a bracket and recognise factors of algebraic terms involving single brackets and simplify expressions by factorising, including subsequently collecting like terms;<br>• Expand the product of two linear expressions, i.e. double brackets working up to negatives in both brackets and also similar to $(2x + 3y)(3x - y)$;<br>• Know that squaring a linear expression is the same as expanding double brackets;<br>• Factorise quadratic expressions of the form $ax^2 + bx + c$;<br>• Factorise quadratic expressions using the difference of two squares. |

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| **Setting up, rearranging and solving equations** | 9 | • Set up simple equations from word problems and derive simple formulae;<br>• Understand the ≠ symbol (not equal), e.g. $6x + 4 \neq 3(x + 2)$, and introduce identity ≡ sign;<br>• Solve linear equations, with integer coefficients, in which the unknown appears on either side or on both sides of the equation;<br>• Solve linear equations which contain brackets, including those that have negative signs occurring anywhere in the equation, and those with a negative solution;<br>• Solve linear equations in one unknown, with integer or fractional coefficients;<br>• Set up and solve linear equations to solve a problem;<br>• Derive a formula and set up simple equations from word problems, then solve these equations, interpreting the solution in the context of the problem;<br>• Substitute positive and negative numbers into a formula, solve the resulting equation including brackets, powers or standard form;<br>• Use and substitute formulae from mathematics and other subjects, including the kinematics formulae $v = u + at$, $v^2 - u^2 = 2as$, and $s = ut + \frac{1}{2}at^2$;<br>• Change the subject of a simple formula, i.e. linear one-step, such as $x = 4y$;<br>• Change the subject of a formula, including cases where the subject is on both sides of the original formula, or involving fractions and small powers of the subject;<br>• Simple proofs and use of ≡ in “show that” style questions; know the difference between an equation and an identity;<br>• Use iteration to find approximate solutions to equations, for simple equations in the first instance, then quadratic and cubic equations. |
| **Sequences** | 9 | • Recognise simple sequences including at the most basic level odd, even, triangular, square and cube numbers and Fibonacci-type sequences (including those involving numbers in standard form or index form);<br>• Generate sequences of numbers, squared integers and sequences derived from diagrams;<br>• Describe in words a term-to-term sequence and identify which terms cannot be in a sequence;<br>• Generate specific terms in a sequence using the position-to-term rule and term-to-term rule;<br>• Find and use (to generate terms) the $n$th term of an arithmetic sequence;<br>• Use the $n$th term of an arithmetic sequence to decide if a given number is a term in the sequence, or find the first term above or below a given number;<br>• Identify which terms cannot be in a sequence by finding the $n$th term;<br>• Continue a quadratic sequence and use the $n$th term to generate terms; |

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| | | • Find the $n$th term of quadratic sequences;<br>• Distinguish between arithmetic and geometric sequences;<br>• Use finite/infinite and ascending/descending to describe sequences;<br>• Recognise and use simple geometric progressions ($rn$ where $n$ is an integer, and $r$ is a rational number > 0 or a surd);<br>• Continue geometric progression and find term to term rule, including negative, fraction and decimal terms;<br>• Solve problems involving sequences from real life situations. |
| **Averages and range** | 9 | • Design and use two-way tables for discrete and grouped data;<br>• Use information provided to complete a two-way table;<br>• Sort, classify and tabulate data and discrete or continuous quantitative data;<br>• Calculate mean and range, find median and mode from a small data set;<br>• Use a spreadsheet to calculate mean and range, and find median and mode;<br>• Recognise the advantages and disadvantages between measures of average;<br>• Construct and interpret stem and leaf diagrams (including back-to-back diagrams):<br>  ○ find the mode, median, range, as well as the greatest and least values from stem and leaf diagrams, and compare two distributions from stem and leaf diagrams (mode, median, range);<br>• Calculate the mean, mode, median and range from a frequency table (discrete data);<br>• Construct and interpret grouped frequency tables for continuous data:<br>  ○ for grouped data, find the interval which contains the median and the modal class;<br>  ○ estimate the mean with grouped data;<br>  ○ understand that the expression ‘estimate’ will be used where appropriate, when finding the mean of grouped data using mid-interval values. |
| **Representing and interpreting data** | 9 | • Know which charts to use for different types of data sets;<br>• Produce and interpret composite bar charts;<br>• Produce and interpret comparative and dual bar charts;<br>• Produce and interpret pie charts:<br>  ○ find the mode and the frequency represented by each sector;<br>  ○ compare data from pie charts that represent different-sized samples;<br>• Produce and interpret frequency polygons for grouped data:<br>  ○ from frequency polygons, read off frequency values, compare distributions, calculate total population, mean, estimate greatest and least possible values (and range);<br>• Produce frequency diagrams for grouped discrete data: |

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| | | ○ read off frequency values, calculate total population, find greatest and least values;<br>• Produce histograms with equal class intervals:<br>○ estimate the median from a histogram with equal class width or any other information, such as the number of people in a given interval;<br>• Produce line graphs:<br>○ read off frequency values, calculate total population, find greatest and least values;<br>• Construct and interpret time-series graphs, comment on trends;<br>• Compare the mean and range of two distributions, or median or mode as appropriate;<br>• Recognise simple patterns, characteristics relationships in bar charts, line graphs and frequency polygons; |
| **Scatter graphs** | 5 | • Draw and interpret scatter graphs in terms of the relationship between two variables;<br>• Draw lines of best fit by eye, understanding what these represent;<br>• Identify outliers and ignore them on scatter graphs;<br>• Use a line of best fit, or otherwise, to predict values of a variable given values of the other variable;<br>• Distinguish between positive, negative and zero correlation using lines of best fit, and interpret correlation in terms of the problem;<br>• Understand that correlation does not imply causality, and appreciate that correlation is a measure of the strength of the association between two variables and that zero correlation does not necessarily imply 'no relationship' but merely 'no linear correlation';<br>• Explain an isolated point on a scatter graph;<br>• Use the line of best fit make predictions; interpolate and extrapolate apparent trends whilst knowing the dangers of so doing. |
| **Fractions** | 7 | • Express a given number as a fraction of another;<br>• Find equivalent fractions and compare the size of fractions;<br>• Write a fraction in its simplest form, including using it to simplify a calculation, e.g. 50 ÷ 20 = $\frac{50}{20}$ = $\frac{5}{2}$ = **2.5**;<br>• Find a fraction of a quantity or measurement, including within a context;<br>• Convert a fraction to a decimal to make a calculation easier;<br>• Convert between mixed numbers and improper fractions;<br>• Add and subtract fractions, including mixed numbers;<br>• Multiply and divide fractions, including mixed numbers and whole numbers and vice versa; |

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| | | • Understand and use unit fractions as multiplicative inverses;<br>• By writing the denominator in terms of its prime factors, decide whether fractions can be converted to recurring or terminating decimals;<br>• Convert a fraction to a recurring decimal and vice versa;<br>• Find the reciprocal of an integer, decimal or fraction; |
| **Percentages** | 9 | • Convert between fractions, decimals and percentages;<br>• Express a given number as a percentage of another number;<br>• Express one quantity as a percentage of another where the percentage is greater than 100%<br>• Find a percentage of a quantity;<br>• Find the new amount after a percentage increase or decrease;<br>• Work out a percentage increase or decrease, including: simple interest, income tax calculations, value of profit or loss, percentage profit or loss;<br>• Compare two quantities using percentages, including a range of calculations and contexts such as those involving time or money;<br>• Find a percentage of a quantity using a multiplier and use a multiplier to increase or decrease by a percentage in any scenario where percentages are used;<br>• Find the original amount given the final amount after a percentage increase or decrease (reverse percentages), including VAT;<br>• Use calculators for reverse percentage calculations by doing an appropriate division;<br>• Use percentages in real-life situations, including percentages greater than 100%;<br>• Describe percentage increase/decrease with fractions, e.g. 150% increase means $2\frac{1}{2}$ times as big;<br>• Understand that fractions are more accurate in calculations than rounded percentage or decimal equivalents, and choose fractions, decimals or percentages appropriately for calculations. |
| **Ratio and proportion 1** | 9 | • Express the division of a quantity into a number parts as a ratio;<br>• Write ratios in form 1 : $m$ or $m$ : 1 and to describe a situation;<br>• Write ratios in their simplest form, including three-part ratios;<br>• Divide a given quantity into two or more parts in a given part : part or part : whole ratio;<br>• Use a ratio to find one quantity when the other is known;<br>• Write a ratio as a fraction and as a linear function;<br>• Identify direct proportion from a table of values, by comparing ratios of values;<br>• Use a ratio to compare a scale model to real-life object;<br>• Use a ratio to convert between measures and currencies, e.g. £1.00 = €1.36; |

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| | | • Scale up recipes;<br>• Convert between currencies. |
| **Polygons, angles and parallel lines** | 9 | • Classify quadrilaterals by their geometric properties and distinguish between scalene, isosceles and equilateral triangles;<br>• Understand ‘regular’ and ‘irregular’ as applied to polygons;<br>• Understand the proof that the angle sum of a triangle is 180°, and derive and use the sum of angles in a triangle;<br>• Use symmetry property of an isosceles triangle to show that base angles are equal;<br>• Find missing angles in a triangle using the angle sum in a triangle AND the properties of an isosceles triangle;<br>• Understand a proof of, and use the fact that, the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices;<br>• Explain why the angle sum of a quadrilateral is 360°; use the angle properties of quadrilaterals and the fact that the angle sum of a quadrilateral is 360°;<br>• Understand and use the angle properties of parallel lines and find missing angles using the properties of corresponding and alternate angles, giving reasons;<br>• Use the angle sums of irregular polygons;<br>• Calculate and use the sums of the interior angles of polygons; use the sum of angles in a triangle and use the angle sum in any polygon to derive the properties of regular polygons;<br>• Use the sum of the exterior angles of any polygon is 360°;<br>• Use the sum of the interior angles of an $n$-sided polygon;<br>• Use the sum of the interior angle and the exterior angle is 180°;<br>• Find the size of each interior angle, or the size of each exterior angle, or the number of sides of a regular polygon, and use the sum of angles of irregular polygons;<br>• Calculate the angles of regular polygons and use these to solve problems;<br>• Use the side/angle properties of compound shapes made up of triangles, lines and quadrilaterals, including solving angle and symmetry problems for shapes in the first quadrant, more complex problems and using algebra;<br>• Use angle facts to demonstrate how shapes would ‘fit together’, and work out interior angles of shapes in a pattern. |

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| **Pythagoras' Theorem and trigonometry** | 9 | • Understand, recall and use Pythagoras' Theorem in 2D;<br>• Given three sides of a triangle, justify if it is right-angled or not;<br>• Calculate the length of the hypotenuse in a right-angled triangle (including decimal lengths and a range of units);<br>• Find the length of a shorter side in a right-angled triangle;<br>• Calculate the length of a line segment $AB$ given pairs of points;<br>• Give an answer to the use of Pythagoras' Theorem in surd form;<br>• Understand, use and recall the trigonometric ratios sine, cosine and tan, and apply them to find angles and lengths in general triangles in 2D figures;<br>• Use the trigonometric ratios to solve 2D problems;<br>• Find angles of elevation and depression;<br>• Know the exact values of sin $\theta$ and cos $\theta$ for $\theta$ = 0°, 30°, 45°, 60° and 90°; know the exact value of tan $\theta$ for $\theta$ = 0°, 30°, 45° and 60°. |
| **Graphs: the basics and real-life graphs** | 7 | • Identify and plot points in all four quadrants;<br>• Draw and interpret straight-line graphs for real-life situations, including ready reckoner graphs, conversion graphs, fuel bills, fixed charge and cost per item;<br>• Draw distance-time and velocity-time graphs;<br>• Use graphs to calculate various measures (of individual sections), including: unit price (gradient), average speed, distance, time, acceleration; including using enclosed areas by counting squares or using areas of trapezia, rectangles and triangles;<br>• Find the coordinates of the midpoint of a line segment with a diagram given and coordinates;<br>• Find the coordinates of the midpoint of a line segment from coordinates;<br>• Calculate the length of a line segment given the coordinates of the end points;<br>• Find the coordinates of points identified by geometrical information.<br>• Find the equation of the line through two given points. |
| **Linear graphs and coordinate geometry** | | • Plot and draw graphs of $y = a$, $x = a$, $y = x$ and $y = -x$, drawing and recognising lines parallel to axes, plus $y = x$ and $y = -x$;<br>• Identify and interpret the gradient of a line segment;<br>• Recognise that equations of the form $y = mx + c$ correspond to straight-line graphs in the coordinate plane;<br>• Identify and interpret the gradient and $y$-intercept of a linear graph given by equations of the form $y = mx + c$;<br>• Find the equation of a straight line from a graph in the form $y = mx + c$; |

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| | | • Plot and draw graphs of straight lines of the form $y = mx + c$ with and without a table of values;<br>• Sketch a graph of a linear function, using the gradient and $y$-intercept (i.e. without a table of values);<br>• Find the equation of the line through one point with a given gradient;<br>• Identify and interpret gradient from an equation $ax + by = c$;<br>• Find the equation of a straight line from a graph in the form $ax + by = c$;<br>• Plot and draw graphs of straight lines in the form $ax + by = c$;<br>• Interpret and analyse information presented in a range of linear graphs:<br>  ○ use gradients to interpret how one variable changes in relation to another;<br>  ○ find approximate solutions to a linear equation from a graph;<br>  ○ identify direct proportion from a graph;<br>  ○ find the equation of a line of best fit (scatter graphs) to model the relationship between quantities;<br>• Explore the gradients of parallel lines and lines perpendicular to each other;<br>• Interpret and analyse a straight-line graph and generate equations of lines parallel and perpendicular to the given line;<br>• Select and use the fact that when $y = mx + c$ is the equation of a straight line, then the gradient of a line parallel to it will have a gradient of $m$ and a line perpendicular to this line will have a gradient of $-\frac{1}{m}$. |
| **Quadratic, cubic and other graphs** | 9 | • Recognise a linear, quadratic, cubic, reciprocal and circle graph from its shape;<br>• Generate points and plot graphs of simple quadratic functions, then more general quadratic functions;<br>• Find approximate solutions of a quadratic equation from the graph of the corresponding quadratic function;<br>• Interpret graphs of quadratic functions from real-life problems;<br>• Draw graphs of simple cubic functions using tables of values;<br>• Interpret graphs of simple cubic functions, including finding solutions to cubic equations;<br>• Draw graphs of the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$ using tables of values;<br>• Draw circles, centre the origin, equation $x^2 + y^2 = r^2$. |

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| **Perimeter, Area & Circles** | 10 | • Recall and use the formulae for the area of a triangle, rectangle, trapezium and parallelogram using a variety of metric measures;<br>• Calculate the area of compound shapes made from triangles, rectangles, trapezia and parallelograms using a variety of metric measures;<br>• Find the perimeter of a rectangle, trapezium and parallelogram using a variety of metric measures;<br>• Calculate the perimeter of compound shapes made from triangles and rectangles;<br>• Estimate area and perimeter by rounding measurements to 1 significant figure to check reasonableness of answers;<br>• Recall the definition of a circle and name and draw parts of a circle;<br>• Recall and use formulae for the circumference of a circle and the area enclosed by a circle (using circumference = $2\pi r = \pi d$ and area of a circle = $\pi r^2$) using a variety of metric measures;<br>• Use $\pi \approx 3.142$ or use the $\pi$ button on a calculator;<br>• Calculate perimeters and areas of composite shapes made from circles and parts of circles (including semicircles, quarter-circles, combinations of these and also incorporating other polygons);<br>• Calculate arc lengths, angles and areas of sectors of circles;<br>• Find radius or diameter, given area or circumference of circles in a variety of metric measures;<br>• Give answers to an appropriate degree of accuracy or in terms of $\pi$;<br>• Form equations involving more complex shapes and solve these equations. |
| **3D forms & Volume, Cylinders, Cones & Spheres** | 9 | • Find the surface area of prisms using the formulae for triangles and rectangles, and other (simple) shapes with and without a diagram;<br>• Draw sketches of 3D solids and identify planes of symmetry of 3D solids, and sketch planes of symmetry;<br>• Recall and use the formula for the volume of a cuboid or prism made from composite 3D solids using a variety of metric measures;<br>• Convert between metric measures of volume and capacity, e.g. 1 ml = 1 $cm^3$;<br>• Use volume to solve problems;<br>• Estimating surface area, perimeter and volume by rounding measurements to 1 significant figure to check reasonableness of answers;<br>• Use $\pi \approx 3.142$ or use the $\pi$ button on a calculator;<br>• Find the volume and surface area of a cylinder;<br>• Recall and use the formula for volume of pyramid;<br>• Find the surface area of a pyramid; |

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| | | • Use the formulae for volume and surface area of spheres and cones;<br>• Solve problems involving more complex shapes and solids, including segments of circles and frustums of cones;<br>• Find the surface area and volumes of compound solids constructed from cubes, cuboids, cones, pyramids, spheres, hemispheres, cylinders;<br>• Give answers to an appropriate degree of accuracy or in terms of $\pi$;<br>• Form equations involving more complex shapes and solve these equations. |