**Subject: Maths**

**Year: 11 (Higher)**

| Autumn HT 1 | Autumn HT 2 | Spring HT 1 | Spring HT 2 | Summer HT 1 | Summer HT 2 |
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| **Multiplicative Reasoning**<br><br>By the end of the unit, students should be able to:<br>• Express a multiplicative relationship between two quantities as a ratio or a fraction, e.g. when *A*:*B* are in the ratio 3:5, *A* is $\frac{3}{5}B$. When 4*a* = 7*b*, then *a* = $\frac{7b}{4}$ or *a*:*b* is 7:4;<br>• Solve proportion problems using the unitary method;<br>• Work out which product offers best value and consider rates of pay;<br>• Work out the multiplier for repeated proportional change as a single decimal number;<br>• Represent repeated proportional change using a multiplier raised to a power, use this to solve problems involving compound interest and depreciation;<br>• Understand and use compound measures and:<br>  • convert between metric speed measures;<br>  • convert between density measures;<br>  • convert between pressure measures;<br>• Use kinematics formulae from the formulae sheet to calculate speed, acceleration, etc (with variables defined in the question);<br>• Calculate an unknown quantity from quantities that vary in direct or inverse proportion;<br>• Recognise when values are in direct proportion by reference to the graph form, and use a graph to find the value of *k* in *y* = *kx*; | **Histograms**<br><br>By the end of the unit, students should be able to:<br>• Know the appropriate uses of histograms;<br>• Construct and interpret histograms from class intervals with unequal width;<br>• Use and understand frequency density;<br>• From histograms:<br>• complete a grouped frequency table;<br>• understand and define frequency density;<br>• Estimate the mean and median from a histogram with unequal class widths or any other information from a histogram, such as the number of people in a given interval.<br><br>**Inequalities**<br><br>By the end of the sub-unit, students should be able to:<br>• Show inequalities on number lines;<br>• Write down whole number values that satisfy an inequality;<br>• Solve simple linear inequalities in one variable, and represent the solution set on a number line;<br>• Solve two linear inequalities in *x*, find the solution sets and compare them to see which value of *x* satisfies both solve linear inequalities in two variables algebraically;<br>• Use the correct notation to show inclusive and exclusive inequalities.<br>• Represent the solution set for inequalities using set notation, i.e. curly brackets and 'is an element of' notation; | **Further Graphs**<br><br>By the end of the unit, students should be able to:<br>• Recognise, sketch and interpret graphs of the reciprocal function $y=\frac{1}{x}$ with *x* ≠ 0<br>• State the value of *x* for which the equation is not defined;<br>• Recognise, sketch and interpret graphs of exponential functions *y* = $k^x$ for positive values of *k* and integer values of *x*;<br>• Use calculators to explore exponential growth and decay;<br>• Set up, solve and interpret the answers in growth and decay problems;<br>• Interpret and analyse transformations of graphs of functions and write the functions algebraically, e.g. write the equation of f(*x*) + *a*, or f(*x* – *a*):<br>  • apply to the graph of *y* = f(*x*) the transformations *y* = –f(*x*), *y* = f(–*x*) for linear, quadratic, cubic functions;<br>  • apply to the graph of y = f(*x*) the transformations *y* = f(*x*) + *a*, *y* = f(*x* + *a*) for linear, quadratic, cubic functions;<br>• Estimate area under a quadratic or other graph by dividing it into trapezia;<br>• Interpret the gradient of linear or non-linear graphs, and estimate the gradient of a quadratic or non-linear graph at a given point by sketching the tangent and finding its gradient; | Responsive teaching based upon February Mock exam question level analysis. | | |

- Set up and use equations to solve word and other problems involving direct proportion (this is covered in more detail in unit 19);
- Relate algebraic solutions to graphical representation of the equations;
- Recognise when values are in inverse proportion by reference to the graph form;
- Set up and use equations to solve word and other problems involving inverse proportion, and relate algebraic solutions to graphical representation of the equations.

- Recognise and interpret graphs showing direct and inverse proportion;
- Identify direct proportion from a table of values, by comparing ratios of values, for $x$ squared and $x$ cubed relationships;
- Write statements of proportionality for quantities proportional to the square, cube or other power of another quantity;
- Set up and use equations to solve word and other problems involving direct proportion;
- Use $y = kx$ to solve direct proportion problems, including questions where students find $k$, and then use $k$ to find another value;
- Solve problems involving inverse proportion using graphs by plotting and reading values from graphs;
- Solve problems involving inverse proportionality;
- Set up and use equations to solve word and other problems involving direct proportion or inverse proportion.

**Similarity and Congruence in 2D and 3D shapes**

- for problems identifying the solutions to two different inequalities, show this as the intersection of the two solution sets, i.e. solution of $x^2 - 3x - 10 < 0$ as $\{x: -3 < x < 5\}$;
- Solve linear inequalities in two variables graphically;
- Show the solution set of several inequalities in two variables on a graph;
- Use iteration with simple converging sequences.

**Quadratics**

By the end of the unit, students should be able to:
- Sketch a graph of a quadratic function, by factorising or by using the formula, identifying roots, $y$-intercept and turning point by completing the square;
- Be able to identify from a graph if a quadratic equation has any real roots;
- Find approximate solutions to quadratic equations using a graph;
- Expand the product of more than two linear expressions;
- Sketch a graph of a quadratic function and a linear function, identifying intersection points;
- Sketch graphs of simple cubic functions, given as three linear expressions;
- Solve simultaneous equations algebraically (where one is linear and one is quadratic)
- Solve simultaneous equations graphically:
  - find approximate solutions to simultaneous equations formed from one linear function and one quadratic function using a graphical approach;
  - find graphically the intersection points of a given straight line with a circle;

- Interpret the gradient of non-linear graph in curved distance–time and velocity–time graphs:
  - for a non-linear distance–time graph, estimate the speed at one point in time, from the tangent, and the average speed over several seconds by finding the gradient of the chord;
  - for a non-linear velocity–time graph, estimate the acceleration at one point in time, from the tangent, and the average acceleration over several seconds by finding the gradient of the chord;
- Interpret the gradient of a linear or non-linear graph in financial contexts;
- Interpret the area under a linear or non-linear graph in real-life contexts;
- Interpret the rate of change of graphs of containers filling and emptying;
- Interpret the rate of change of unit price in price graphs.

**Vectors**

By the end of the unit, students should be able to:
- Understand and use vector notation, including column notation, and understand and interpret vectors as displacement in the plane with an associated direction.
- Understand that $2\mathbf{a}$ is parallel to $\mathbf{a}$ and twice its length, and that $\mathbf{a}$ is parallel to $-\mathbf{a}$ in the opposite direction.
- Represent vectors, combinations of vectors and scalar multiples in the plane pictorially.
- Calculate the sum of two vectors, the difference of two vectors and a scalar multiple of a vector using column vectors (including algebraic terms).

By the end of the unit, students should be able to:

- Understand and use SSS, SAS, ASA and RHS conditions to prove the congruence of triangles using formal arguments, and to verify standard ruler and pair of compasses constructions;
- Solve angle problems by first proving congruence;
- Understand similarity of triangles and of other plane shapes, and use this to make geometric inferences;
- Prove that two shapes are similar by showing that all corresponding angles are equal in size and/or lengths of sides are in the same ratio/one is an enlargement of the other, giving the scale factor;
- Use formal geometric proof for the similarity of two given triangles;
- Understand the effect of enlargement on angles, perimeter, area and volume of shapes and solids;
- Identify the scale factor of an enlargement of a similar shape as the ratio of the lengths of two corresponding sides, using integer or fraction scale factors;
- Write the lengths, areas and volumes of two shapes as ratios in their simplest form;
- Find missing lengths, areas and volumes in similar 3D solids;
- Know the relationships between linear, area and volume scale factors of mathematically similar shapes and solids;

- Use the relationship between enlargement and areas and volumes of simple shapes and solids;

  - solve simultaneous equations representing a real-life situation graphically, and interpret the solution in the context of the problem;
- Solve quadratic inequalities in one variable, by factorising and sketching the graph to find critical values;

**Formula**

By the end of the unit, students should be able to:

- Rationalise the denominator involving surds;
- Simplify algebraic fractions;
- Multiply and divide algebraic fractions;
- Solve quadratic equations arising from algebraic fraction equations;
- Change the subject of a formula, including cases where the subject occurs on both sides of the formula, or where a power of the subject appears;
- Change the subject of a formula such as $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$, where all variables are in the denominators;

**Functions**

- Solve 'Show that' and proof questions using consecutive integers ($n$, $n$ + 1), squares $a^2$, $b^2$, even numbers 2$n$, odd numbers 2$n$ +1;
- Use function notation;
- Find f($x$) + g($x$) and f($x$) – g($x$), 2f($x$), f(3$x$) etc algebraically;
- Find the inverse of a linear function;
- Know that $f^{-1}(x)$ refers to the inverse function;
- For two functions f($x$) and g($x$), find gf($x$).

- Find the length of a vector using Pythagoras' Theorem.
- Calculate the resultant of two vectors.
- Solve geometric problems in 2D where vectors are divided in a given ratio.
- Produce geometrical proofs to prove points are collinear and vectors/lines are parallel.

**Circle Geometry**

By the end of the sub-unit, students should be able to:

- Recall the definition of a circle and identify (name) and draw parts of a circle, including sector, tangent, chord, segment;
- Prove and use the facts that:
  - the angle subtended by an arc at the centre of a circle is twice the angle subtended at any point on the circumference;
  - the angle in a semicircle is a right angle;
  - the perpendicular from the centre of a circle to a chord bisects the chord;
  - angles in the same segment are equal;
  - alternate segment theorem;
  - opposite angles of a cyclic quadrilateral sum to 180°;
- Understand and use the fact that the tangent at any point on a circle is perpendicular to the radius at that point;
- Find and give reasons for missing angles on diagrams using:
  - circle theorems;
  - isosceles triangles (radius properties) in circles;
  - the fact that the angle between a tangent and radius is 90°;

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| • Solve problems involving frustums of cones where you have to find missing lengths first using similar triangles.<br><br>**<u>Further Graphs and Trigonometry</u>**<br><br>By the end of the unit, students should be able to:<br>• Recognise, sketch and interpret graphs of the trigonometric functions (in degrees)<br>$y = \sin x$, $y = \cos x$ and $y = \tan x$ for angles of any size.<br>• Know the exact values of $\sin\theta$ and $\cos\theta$ for $\theta = 0°, 30°, 45°, 60°$ and $90°$ and exact value of $\tan\theta$ for $\theta = 0°, 30°, 45°$ and $60°$ and find them from graphs.<br>• Apply to the graph of $y = f(x)$ the transformations $y = -f(x)$, $y = f(-x)$ for sine, cosine and tan functions $f(x)$.<br>• Apply to the graph of $y = f(x)$ the transformations $y = f(x) + a$, $y = f(x + a)$<br>for sine, cosine and tan functions $f(x)$.<br><br>• Know and apply Area = $\frac{1}{2}ab \sin C$ to calculate the area, sides or angles of any triangle.<br>• Know the sine and cosine rules, and use to solve 2D problems (including involving bearings).<br>• Use the sine and cosine rules to solve 3D problems.<br>• Understand the language of planes, and recognise the diagonals of a cuboid.<br>• Solve geometrical problems on coordinate axes.<br>• Understand, recall and use trigonometric relationships and Pythagoras' Theorem in right-angled triangles, and use these to solve problems in 3D configurations. | | • the fact that tangents from an external point are equal in length.<br>• Select and apply construction techniques and understanding of loci to draw graphs based on circles and perpendiculars of lines;<br>• Find the equation of a tangent to a circle at a given point, by:<br>• finding the gradient of the radius that meets the circle at that point (circles all centre the origin);<br>• finding the gradient of the tangent perpendicular to it;<br>• using the given point;<br>• Recognise and construct the graph of a circle using $x^2 + y^2 = r^2$ for radius $r$ centred at the origin of coordinates. | |

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| • Calculate the length of a diagonal of a cuboid.<br>• Find the angle between a line and a plane. | | | |

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