Knowledge Grid Mathematics- Year 9

Week From 39-week plan	**Tier 3 Vocabulary with key definitions** **Tier 3 words** are subject-specific, used within a particular field. For example, the language of scientists, mathematicians, historians, and literary critics. For maths, this includes words like 'denominator', while science lessons might require learners to understand 'homeostasis'.	**Substantive Knowledge** The specific, factual concepts needed for the topic or subject. (Detail for each included in lesson resources)	**Common Misconceptions** Any idea that students do not accurately understand when studying this content, concept or subject. (Updated live by teachers when misconceptions occur)
1 2	**<u>Straight line graphs</u>** **Axis** -A fixed, reference line along which or from which distances or angles are taken **Equation** - A mathematical statement showing that two expressions are equal. The expressions are linked with the symbol = **Graph** - A diagram showing a relationship between variables. Adjective: graphical Intercept **Linear** - in algebra, describing an expression or equation of degree one. Example: 2x + 3y = 7 is a linear equation. All linear equations can be represented as straight line graphs. **Function** - A function is a relation between a set of inputs and a set of permissible outputs with the property that each input is related to exactly one output	How to use lines parallel to the axes y = x and y = −x How to use tables of values How to compare gradients How to compare intercepts How to understand and use y = mx + c How to write an equation in the form y = mx + c	Students getting the x and y coordinate the wrong way Students identifying y = lines to be parallel to the y-axis not perpendicular to Students incorrectly working with negative numbers when substituting Students getting the gradient and the y-intercept the wrong way round

	Gradient - A measure of the slope of a line. **Intercept** - On a graph, the value of the non-zero coordinate of the point where a line cuts an axis. **Coordinate** - In geometry, a coordinate system is a system which uses one or more numbers, or coordinates, to uniquely determine the position of a point in space **Direct proportion** - Two variables x and y are in direct proportion if the algebraic relation between them is of the form y = kx, where k is a constant. The graphical representation of this relationship is a straight line through the origin, and k is the gradient of the line. **Coefficient** - Often used for the numerical coefficient. More generally, a factor of an algebraic term. Example: in the term 4xy, 4 is the numerical coefficient of xy but x is also the coefficient of 4y and y is the coefficient of 4x	How to find the equation of a line from a graph How to interpret gradient and intercepts of real-life graphs How to model real-life graphs involving inverse proportion How to explore perpendicular lines	Students thinking that the gradients in mx rather than just m (the coefficient of x) Students think that parallel lines means that the y-intercept are the same
3 4	**<u>Forming and solving equations</u>** **Equation** - A mathematical statement showing that two expressions are equal. The expressions are linked with the symbol = **Inequality** - When one number, or quantity, is not equal to another. Statements such as a ≠ b, a b or a ≥ b are inequalities	How to solve one- and two-step equations and inequalities How to solve one- and two-step equations and inequalities with brackets	Students not doing the inverse operations Students not know the correct inverse operations Students not doing the same on both

	Inverse - Operations that, when they are combined, leave the entity on which they operate unchanged. Examples: addition and subtraction are inverse operations e.g. 5 + 6 – 6 = 5 **Expand** - Expand is when we multiply to remove the ( ) **Coefficient** - Often used for the numerical coefficient. More generally, a factor of an algebraic term. Example: in the term 4xy, 4 is the numerical coefficient of xy but x is also the coefficient of 4y and y is the coefficient of 4x **Substitute** - Numbers can be substituted into an algebraic expression in x to get a value for that expression for a given value of x **Subject** - A formula relates different physical variables in a mathematical way **Variable** - A quantity that can take on a range of values, often denoted by a letter, x, y, z, t, … etc.	How to use inequalities with negative numbers How to solve equations with unknowns on both sides How to solve inequalities with unknowns on both sides How to solve equations and inequalities in context How to Substitute into formulae and equations How to rearrange formulae (one-step) How to rearrange formulae (two-step) How to rearrange complex formulae	sides of the equations Students not doing the correct order of steps

		including brackets and squares	
5 6	**<u>Testing conjectures</u>** **Factor** - When a number, or polynomial in algebra, can be expressed as the product of two numbers or polynomials, these are factors of the first **Multiple** - For any integers a and b, a is a multiple of b if a third integer c exists so that a = bc **Prime** - A whole number greater than 1 that has exactly two factors, itself and 1 **Conjecture** - An educated guess (or otherwise!) of a particular result, which is as yet unverified **Expand** - Expand is when we multiply to remove the ( ) **Factorise** - To express a number or a polynomial as the product of its factors **Binomial** - an expression that has two unlike terms connected through an addition or subtraction operator in between **Term** - is any single number or variable **Expression** - Numbers, symbols and operators (such as + and ×) grouped together that show the value of something.	How to use Factors, Multiples and Primes How to use True or False? How to work with Always, Sometimes, Never true How to use Show that How to use conjectures about number How to expand a pair of binomials How to use conjectures with algebra How to explore the 100 grid	Students get factors and multiples the wrong way round Students get the HCF and the LCM the wrong way round Students don't find the HCF, they just find the common factor Students are not able to demonstrate clearly (upgrading answers needed)

	Quadratic - Describing a expression of the form ax2 + bx + c where a, b and c are real numbers.	How to expand three binomials	
7 8 9	**<u>Three Dimensional Shapes</u>** **Tetrahedron** - A solid with four triangular faces. A regular tetrahedron has faces that are equilateral triangles. Plural: tetrahedra **Vertex** - The point at which two or more lines intersect. Plural: vertices **Polygon** - A closed plane figure bounded by straight lines. The name derives from many angles. **Face** - One of the flat surfaces of a solid shape. Example: a cube has six faces; each face being a square **Edge** - A line segment, joining two vertices of a figure. A line segment formed by the intersection of two plane surfaces. Examples: a square has four edges; and a cuboid has twelve edges. **Cross-section** - In geometry, a section in which the plane that cuts a figure is at right angles to an axis of the figure. Example: In a cube, a square revealed when a plane cuts at right angles to a face. **Net** – A plane figure composed of polygons which by folding and joining can form a polyhedron	Know names of 2D and 3D shapes How to recognise prisms How to draw accurate nets of cuboids and other 3D shapes How to use plans and elevations How to find the area of 2D shapes How to find surface area of cubes and cuboids How to find surface area of triangular prisms How to find the surface area of a cylinder	Students identify the 2D shape and the 3D and vice versa Students get pyramid and prism the wrong way round Students get the cross section of a 3D shape Students get the wrong plan or elevations Students forget to divide by 2 with the area of a triangle Students don't use the perpendicular height when finding the area Students don't include all sides

	Dimension – the measure of the size or distance of an object or region or space in one direction **Compound** - Measures with two or more dimensions. Examples: speed calculated as distance ÷ time; density calculated as mass ÷ volume; car efficiency **Units** - A standard used in measuring e.g. the metre is a unit of length; the degree is a unit of turn/angle, etc.	How to find the volume of cubes and cuboids How to volume of other 3D shapes – prisms and cylinders How to explore volumes of cones, pyramids and spheres	when finding the surface area Students substitute the wrong values into formula when finding the volume
10 11 12	**<u>Constructions and congruency</u>** **Acute** - An angle between 0 degrees and 90 degrees **Obtuse** - An angle greater than 90 degrees but less than 180 degrees. **Reflex** - An angle that is greater than 180 degrees but less than 360 degrees **Scale** - To enlarge or reduce a number, quantity or measurement by a given amount (called a scale factor) or An accurate drawing, or model, of a representation of a physical object in which all lengths in the drawing are in the same ratio to corresponding lengths in the actual object **Ratio** - A part to part comparison. The ratio of a to b is usually written a : b.	How to draw and measure angles How to construct and interpret scale drawings How to use locus of distance from a point How to locus of distance from a straight line/ shape How to locus equidistant from two points	Students use the wrong side of the protractor (start counting from 180 instead of 0) Students angle the protractor perpendicular to where it is meant to start Students hold onto the compass to tightly Students draw arcs from the middle of the lines

	Multiplier - The number that you are multiplying by. But because we can multiply the two numbers in any order, it is better to use the word "factor". **Locus** - The set of all points that share a property. This usually results in a curve or surface. **Equidistant** - The same distance (from each other, or in relation to other things) **Point** - An element, in geometry, that has position but no magnitude **Vertex** - The point at which two or more lines intersect. Plural: vertices **Line segment** - The part of a line between two points. Within a circle, the region bound by an arc and the chord joining its two end points. **Arc** - A portion of a curve. Often used for a portion of a circle. **Bisector** - A point, line or plane that divides a line, an angle or a solid shape into two equal parts. A perpendicular bisector is a line at right angles to a line-segment that divides it into two equal parts. **Scalene** - A triangle with no two sides equal and consequently no two angles equal.	How to construct a perpendicular bisector How to construct a perpendicular from a point How to construct a perpendicular to a point How to locus of distance from two lines How to construct an angle bisector How to construct triangles from given information How to identify congruent figures Explore congruent triangles How to identify congruent triangles	Students draw the arcs of same lengths when constructing scalene triangles Students don't draw arcs with the same lengths when bisecting Students don't round the corners when constructing locus from a straight line

	Congruent - Two or more geometric figures are said to be congruent when they are the same in every way except their position in space. Example: Two figures, where one is a reflection of the other, are congruent since one can be transposed onto the other without changing any angle or edge length		
13	Assessment and LC1		
14 15	**<u>Numbers</u>** **Integer** - Any of the positive or negative whole numbers and zero **Real** - A number that is rational or irrational. Real numbers are those generally used in everyday contexts, but in mathematics, or the physical sciences, or in engineering, or in electronics the number system is extended to include what are known as complex numbers. In school mathematics to key stage 4 all the mathematics deals with real numbers. Integers form a subset of the real numbers. **Rational** - A number that is an integer or that can be expressed as a fraction whose numerator and denominator are integers, and whose denominator is not zero. **Irrational** - A number that is not an integer and cannot be expressed as a common fraction with a non-zero denominator **Root** - Where a function equals zero.	How to use integers, real and rational numbers How to understand and use surds How to work with directed number How to solve problems with integers How to solve problems with decimals How to use HCF and LCM How to add and subtract fractions	Students don't square root the square number when simplifying surds Students think that square root means dividing the number by two Students get factors and multiples the wrong way round Students get the HCF and the LCM the wrong way round Students don't find the HCF, they just find the common factor

	Surd - 1. An irrational number expressed as the root of a natural number. Examples: 3√2. 2. A numerical expression involving irrational roots. Example: 3 + 2√7 **Directed** - A number having a direction as well as a size e.g. -7, +10, etc. Such numbers can be usefully represented on a number line extending in both directions from zero. **Quotient** - The result of a division. Example: 46 ÷ 3 = 15⅓ and 15⅓ is the quotient of 46 by 3 **Product** - The result of multiplying one number by another. Example: The product of 2 and 3 is 6 since 2 × 3 = 6. **Sum** - The result of one or more additions. **Operation** - A rule for combining two numbers in the set to produce a third also in the set. Addition, subtraction, multiplication and division of real numbers are all binary operations. **Remainder** - In the context of division requiring a whole number answer (quotient), the amount remaining after the operation. Example: 29 divided by 7 = 4 remainder 1. **Factor** - When a number, or polynomial in algebra, can be expressed as the product of two numbers or polynomials, these are factors of the first	How to multiply and divide fractions How to solve problems with fractions How to use numbers in standard form	Students don't find a common denominator Students don't use a negative power when working with small units of standard form

	Numerator - In the notation of common fractions, the number written on the top – the dividend (the part that is divided). In the fraction ⅔, the numerator is 2 **Denominator** - In the notation of common fractions, the number written below the line i.e. the divisor. Example: In the fraction ⅔ the denominator is 3. **Improper** - An improper fraction has a numerator that is greater than its denominator. Example: 9 /4 is improper and could be expressed as the mixed number 2¼		
16 17	**<u>Using Percentages</u>** **Covert** - Changing from one quantity or measurement to another **Equivalent** - A numerical or algebraic expression which is the same as the original expression, but is in a different form which might be more useful as a starting point to solve a particular problem **Multiplier** - The number that you are multiplying by. But because we can multiply the two numbers in any order, it is better to use the word "factor". **Index** - Where index notation is used and numbers raised to powers are multiplied or divided, the rules for manipulating index numbers. Examples: 2a × 2b = 2a + b and 2a ÷ 2b = 2a – b	How to use the equivalence of FDP How to calculate percentage increase and decrease How to express a change as a percentage How to solve 'reverse' percentage problems How to recognise and solve	Students don't multiply/ divide by 100 correctly when converting between percentage and decimal Students think that the multiplier for a 3% increase is 0.03 or 1.3 Students don't take the percentage off 100 when finding a decreasing multiplier

		percentage problems (non-calc) How to recognise and solve percentage problems (calc) How to solve problems with repeated percentage change	
18 19	**<u>Maths and Money</u>** **Expense** - Money spent on items or services **Debit** - The opposite of credit. In Banking when you withdraw money or make purchases, your bank account is debited, reducing the balance. Debit cards are used for transactions that directly withdraw funds from your account **Credit** - The trust that lets people give things (like goods, services or money) to other people in the hope they will repay later on **Principal** - The total amount of money borrowed (or invested), not including any interest or dividends **Annual** - Something that happens once a year	How to solve problems with bills and bank statement How to calculate simple interest How to calculate compound interest How to solve problems with Value Added Tax How to calculate wages and taxes	Students struggle with the difference between debt and debit Students don't know the difference between simple and compound interest Students get the multiplier wrong, for increase by 3% they either put 1.3 or 0.03 or 0.3 Students don't subtract away from

	Rate - A comparison of two related quantities. Often written "this per that" but there are many possibilities, including a single number calculated using division **VAT** - Value added tax is payable to the government by a business. VAT is a purchase tax added onto items that are bought, except things that are zero-rated, such as food, because these are deemed essentials.	How to solve problems with exchange rates How to solve unit pricing problems	100% when looking at depreciation
20 21	**<u>Deduction</u>** **Alternative** - When two lines are crossed by another line (the Transversal), a pair of angles • on the outer side of those two lines • but on opposite sides of the transversal **Corresponding** - When two lines are crossed by another line (which is called the Transversal), the angles in matching corners are called corresponding angles **Transversal** - A line that crosses at least two other lines **Regular** - Regular has many meanings in mathematics. A regular shape has all sides equal and all angles equal **Polygon** - A plane shape (two-dimensional) with straight sides **Bisector** - A point, line or plane that divides a line, an angle or a solid shape into two equal parts. A perpendicular bisector is a line at right angles to a line-segment that divides it into two equal parts.	How to use angles in parallel lines How to solve angle problems (using chains of reasoning) How to use angle problems with algebra How to do conjectures with angles How to do conjectures with shapes How to link constructions and geometrical reasoning	Students are not able to identify corresponding or alternate angles Students think that co-interior angles are equal Students think that multiple angles add to make a straight line even when they are not around the same point Students think that a polygon only has 5 sides (thinking it is a pentagon)

22	**<u>Rotation and Translation</u>** **Regular** - Regular has many meanings in mathematics. A regular shape has all sides equal and all angles equal **Irregular** - Not regular. Has many meanings in mathematics. A regular shape has all sides equal and all angles equal. So an irregular shape has at least one side different to the other sides, or angle different to the other angles **Rotational** - A shape has Rotational Symmetry when it still looks the same after some rotation **Symmetry** - When two or more parts are identical after a flip, slide or turn. The simplest type of Symmetry is "Reflection" (or "Mirror") Symmetry, as shown in this picture of my dog Flame. **Invariant** - A property that does not change after certain transformations. Example: the side lengths of a triangle don't change when the triangle is rotated. So we can say "triangle side lengths are invariant under rotation". **Vector** - A vector has magnitude (how long it is) and direction. **Variant** - A measure of how spread out numbers are.	How to identify the order of rotational symmetry of a shape How to compare and rotational symmetry with lines of symmetry How to rotate a shape about a point on a shape How to rotate a shape about a point not on a shape How to translate points and shapes by a given vector How to compare rotation and reflection of shapes How to find the result of a series of transformations	Students
23			
24			

25	**<u>Pythagoras</u>** **Significant figures** - The number of digits that are meaningful: they have an accuracy matching our measurements or are simply all we need. **Hypotenuse** – The side opposite the right angle in a right-angled triangle. It is also the longest side of the right-angled triangle. **Adjacent** - Lying next to each other. **Gradient** - How steep a line is. **Quadrant** - Any of the 4 areas made when we divide up a plane by an **x** and **y** axis, as shown. **Origin** - The starting point. Sometimes written as the capital letter **O** • On a number line it is 0, • On a two-dimensional graph it is where the X axis and Y axis cross, such as on the graph here: • In three dimensions it is the point (0, 0, 0) where the x, y and z axes cross:	How to use squares and square roots How to identify the hypotenuse of a right-angles triage How to determine whether a triangle is right-angled How to calculate the hypotenuse of a right-angled triangle Calculate missing sides in right-angled triangles How to use Pythagoras' theorem on coordinate axes Explore proofs of Pythagoras' theorem How to use Pythagoras' theorem in 3-D shapes	Students think that square rooting something means dividing it by 2 Students can't identify the hypotenuse correctly Students don't understand that the hypotenuse is the longest side of the triangle and so when finding a missing side that isn't the hypotenuse, students still add the square numbers Students get the x and the y the wrong way round in the coordinate

<table>
<tr><td>26</td><td colspan="3">Assessment and LC2</td></tr>
<tr><td>27
28</td><td><u>Enlargement and Similarity</u>

Similar - When one shape can become another after a resize, flip, slide or turn.

Corresponding - When two lines are crossed by another line (which is called the Transversal), the angles in matching corners are called corresponding angles.

Scale factor - The ratio of the length in a drawing (or model) to the length on the real thing

Ratio - A ratio shows the relative sizes of two or more values.
Ratios can be shown in different ways:
• using the ":" to separate example values
• using the "/" to separate one value from the total
• as a decimal, after dividing one value by the total
• as a percentage, after dividing one value by the total

Orientation - the action of orienting someone or something relative to the points of a compass or other specified positions

Inverted - means the opposite in effect. The reverse of.</td><td>How to recognise enlargement and similarity

How to enlarge a shape by a positive integer scale factor

How to enlarge a shape by a scale factor from a point

How to enlarge a shape by a positive fractional scale factor

How to enlarge a shape by a negative scale factor

How to work out missing sides and angles in a pair of given similar shapes

How to solve problems with similar triangles</td><td>Students don't enlarge all the sides by the same amount

Students think that enlargement only means a shape getting larger

Students don't understand that when enlarging a shape from a point, not only does it have to be enlarged by the scale factor, but it also has to be that scale factor more/less away from the point</td></tr>
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		How to explore ratios in right-angled triangles	
29 30	**<u>Solving Ratio and Problems</u>** **Non-linear** – not linear, not a straight line **Variable** - A quantity that can take on a range of values, often denoted by a letter, x, y, z, t, … etc. Gradient **Relationship** - a connection between the elements of two sets. **Inverse** - means the opposite in effect. The reverse of. **Constant** - A fixed value. In Algebra, a constant is a number on its own, or sometimes a letter such as a, b or c to stand for a fixed number. **Equivalent** - Having the same value. Examples: 1 Dollar is equivalent to 100 cents 120 seconds is equivalent to 2 minutes	How to solve problems with direct proportion How to use direct proportion and conversion graphs How to solve problems with inverse proportion How to use graphs of inverse relationships How to solve ratio problems given the whole or a part How to solve 'best buy' problems How to solve problems involving ratio and algebra	Students don't multiply the sides of the equals by the same amount Students don't understand what direct proportion looks like on a graph Students think that inverse proportion with worded with is the same as direct proportion
31			

32	**Rates** **Rate** - A comparison of two related quantities. Often written "this per that" but there are many possibilities, including a single number calculated using division **Covert** - Changing from one quantity or measurement to another **Accuracy** - how close a measured value is to the actual (true) value. **Average** - A calculated "central" value of a set of numbers. To calculate it: add up all the numbers, then divide by how many numbers there are. **Imperial** - A system of weights and measures originally developed in England. Similar but not always the same as US standard units. Example of Imperial measures: Length: inches, feet, yards Area: square feet, acres Weight: pounds, ounces, Volume: fluid ounces, gallons **Metric** - A system of measuring based on: · The meter for length · The kilogram for mass · The second for time	How to solve speed, distance and time problems without a calculator How to solve speed, distance and time problems with a calculator How to use distance-time graphs How to solve problems with density, mass and volume How to solve flow problems and their graphs How to use rates of change and their units How to convert compound units	Students don't remember the speed distance time formula (teachers, aim to not teach it this way, use it all as proportional to each other) Students don't remember the density volume density formula (teachers, aim to not teach it this way, use it all as proportional to each other) Students think that converting smaller units of measurement into larger units of measurement involves multiplying instead of dividing
33			

34	**Probability** **Event** - One (or more) outcomes of an experiment **Outcome** - A possible result of an experiment. Example: rolling a 1, 2, 3, 4, 5 or 6 are all outcomes. **Fair** – situations where all outcomes are equivalent (e.g., a fair coin toss **Trial** - In Probability: A single run of an experiment. **Experiment** - Something that can be repeated that has a set of possible results. **Independent** - An event that is not affected by other events. Example: tossing a coin. Heads or tails is not affected by previous tosses. **Product** - The answer when two or more values are multiplied together. **Intersection** – Geometry: Where lines cross over (where they have a common point). Sets: only the elements that are in both sets	How to find the probability of a single event How to use relative frequency How to find expected outcomes How to find independent events How to use tree diagrams How to use tree diagrams to solve 'without replacement' probability How to use diagrams to work out probabilities	Students don't understand that mutually exclusive events add to 1 Students don't know how to link the probability to fractions Students write the denominator as the rest of the outcomes rather than the total Students add along the branches of a tree diagram
35	**Algebraic Representation** **Quadratic** - Where the highest exponent of the variable (usually "x") is a square (^{2})	How to draw and interpret quadratic graphs	Students don't substitute negative numbers correctly

	Parabola - A special curve that can look like an arch. **Reciprocal** - The reciprocal of a number is 1 divided by the number. Examples: • the reciprocal of 2 is 1/2 (half) • the reciprocal of 10 is 1/10 (=0.1) **Exponential** - Where a value increases in proportion to its current value. Such as always doubling. **Discontinuous** – having intervals/ gaps	How to interpret other graphs, including reciprocal and piece-wise Investigate graphs of simultaneous equations How to represent inequalities	when drawing quadratic graphs Students have reciprocal graphs touch the axis Students get the inequalities the wrong way round
36	Revision		
37	Assessment		
38	CTG		
39			