MATHS KNOWLEDGE ORGANISER

Topic/Skill	Definition
NUMBER	
Integer	A whole number.
Positive	A number **greater than** zero
Negative	A number **less than** zero
Decimal place	The number of digits **after** the decimal point
Operations	**Symbols** and **words** used to show how to combine numbers
	x **Multiply** + **Add** ÷ **Divide** - **Subtract**
Sum	To **add** numbers together
Product	To **multiply** numbers together
Less than	A number which is **smaller** than another number is said to be **less than.**
Greater than	A number which is **larger** than another number is said to be **greater than.**
Round	Change a number to a simpler and easy to use value
Multiple	The result of multiplying a number by an integer. The **times tables** of a number.
Factor	A number that **divides exactly** into another number without a remainder. It is useful to write factors in pairs
Lowest Common Multiple (LCM)	The **smallest** number that is in the **times tables** of each of the numbers given.
Highest Common Factor (HCF)	The **biggest** number that **divides exactly** into two or more numbers.
Prime Number	A number with **exactly two factors**. A number that can only be divided by itself and one. The number **1 is not prime**, as it only has one factor, not two.
Square Number	The number you get when you **multiply a number by itself**.
Square Root	The **number you multiply by itself** to get another number. The reverse process of squaring a number.
Cube Number	The number you get when you **multiply a number by itself and itself again**.
Cube Root	The **number you multiply by itself and itself again** to get another number. The inverse process of cubing a number.

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Addition and subtraction with negatives	**Add positive** number is same as **add** + + means + **Subtract positive** number is same as **subtract** - + means - **Add negative** number is same as **subtract** + - means - **Subtract negative** number is same as **add** - - means +
Multiplication and division with negatives	**positive × positive = positive** positive ÷ positive = positive **positive × negative = negative** positive ÷ negative = negative **negative × positive = negative** negative ÷ positive = negative **negative × negative = positive** negative ÷ negative = positive
14. BIDMAS	**BRACKETS** **INDICES** **DIVISION** **MULTIPLICATION** **ADDITION** **SUBTRACTION**
15. Estimate	Round each number in the calculation to **1 significant figure.** $\approx$means 'approximately equal to'260
16. Share	This means to **divide** , so to share £36 between 10 people is $\frac{36}{10} = £3.60$
17. Product	The answer when two values are multiplied together
ALGEBRA	
1.Expand	Multiply out the bracket(s) $x(x+3) becomes\ x^2 + 3x$
2. Factorise	Put it back into brackets so $3a + 21a^2\ becomes\ 3a(1+7a)$
3. Simplify	Collect the "like" terms together. So $4x + 7q - x + 3q = 3x + 10q$

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4. Expression	A collection of terms which contain variables (letters) and numbers BUT NO EQUAL SIGN
5. Formula	An equation used to describe a relationship between two or more variables.
Geometry	
1. Diameter	The length of the line through the centre of the circle that touches two points on the edge of the circle. (Remember $d = 2r$ or the diameter is double the radius)
2. Radius	Is the length of the line though the centre of the circle that touches one point on the edge of the circle.
3. Gradient	How steep a line is, so the line $y = 3x + 5$ has a gradient of 3 and a y-intercept of 5.
4. Circumference	The perimeter of a circle $c = \pi d$
5. Perpendicular	Two or more likes which meet at right angles
6. Parallel	Two lines that never meet
7. Types of angles	**Acute** angle = an angle less than 90º **Right** angle = a 90º angle **Obtuse** angle = an angle more than 90º but less than 180º **Reflex** angle – an angle more than 180º
8. Area	The amount of space a shape takes up
9. Types of triangle	**Equilateral** All sides are the same length. Each internal angle is 60º **Right angled** Triangle that contains a 90º angle **Scalene** Triangle that has three different side lengths **Isosceles** Triangle that has two sides (and two base angles) the same.
10. Quadrilateral	A four sided polygon

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11.	
12.	
13.	
14.	
15.	

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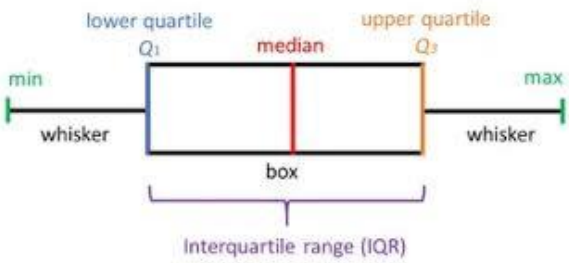
Topic/Skill	Definition
Sample	A selection taken from a larger group (known as the population) to help you find things about the larger group)
Population	The whole group that is being studied
Primary Data	Data that is collected by somebody from first hand sources using methods like surveys, interviews or experiments
Secondary Data	Data gathered from studies that have been run by other people or for other research
Discrete Data	Data that is counted and can only take certain values e.g. the number of students in a class
Continuous Data	Data can take any value (within a range) e.g. a person's height or a time in a race
Random Sample	A selection that is chosen randomly. Every member of the population being studied should have an equal chance of being selected
Stratified Sampling	Sampling method where total population divided into smaller groups (or subpopulations)
Cumulative Frequency	The 'running total' of the frequencies. Graph plotted at end points and forms an 'S' shape
Quartiles	Data is divided into quarters. Lower quartiles (LQ), Upper quartile (UQ)
Inter-Quartile Range (IQR)	Upper Quartile – Lower Quartile = Inter-Quartile Range
Box Plots	A diagram showing lowest value, LQ, Median, UQ & highest value 
Histograms	A way of representing data but unlike bar charts they show frequency density rather than frequency and often have bars of unequal width
Frequency Density	Frequency ÷ Class Width = Frequency Density

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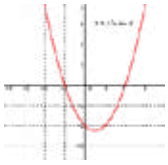
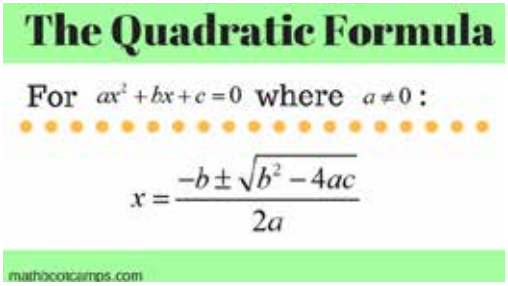
Topic/Skill	**Definition**
Quadratic	Highest exponent (or power) of the variable is a square e.g. $3x^2 + 5x = 0$
Graphs of Quadratic Functions	Parabola or 'u' shape 
Roots	Where a function equals zero. For quadratics this is often where the graph crosses the x-axis. (Can be found by factorizing quadratics)
Y-intercept	Where a line or curve crosses the y-axis
Turning Point	This is where the curve changes direction so the graph will change gradient from positive to negative and vice versa
Simultaneous Equations	Solving 2 equations that share variables. This can be done algebraically or graphically (where the lines/curves intersect)
Iteration	Repeating a process to solve more complex equations
Quadratic Formula	Formula used to solve complex quadratics that can't be factorised: 

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Topic/Skill	Definition
Identify & Draw parts of a circle	This will include sector, segment, tangent, chord, radius, diameter & circumference
Prove & Use Circle Theorems	The angle at the centre of a circle is twice the angle at the circumference
	The angle in a semi-circle is always 90°
	Angles in the same segment are always equal
	Alternate segment theorem – Angle between a chord and a tangent is equal to the angle in the alternate segment
	Opposite angles of cyclic quadrilateral sum to 180°
	The perpendicular from the centre of a circle to a chord bisects the chord
	Angle between a tangent and radius is 90°
	Tangents from a common point are equal in length

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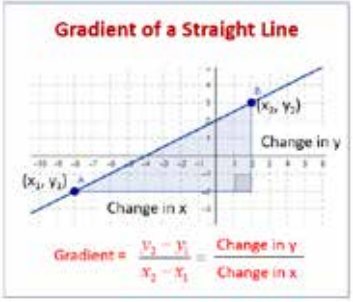
Topic/Skill	Definition
Equation of a circle	$(x-a)^2 + (y-b)^2 = r^2$
Gradient	How steep a line is. 
Perpendicular Lines	If two lines are perpendicular then their gradients multiply to give –1. Referred to as the negative reciprocal
Find the length of a line segment	Use given coordinates and Pythagoras Theorem to calculate the length of a line
Circle Theorem	Angle between a tangent and radius is 90°

MATHS KNOWLEDGE ORGANISER

Topic/Skill	Definition
Identify & Draw parts of a circle	This will include sector, segment, tangent, chord, radius, diameter & circumference
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	The perpendicular from the centre of a circle to a chord bisects the chord
	Angle between a tangent and radius is 90°
	Tangents from a common point are equal in length

MATHS KNOWLEDGE ORGANISER

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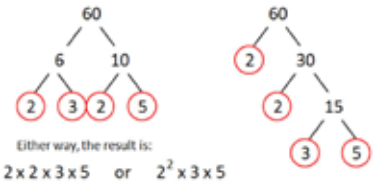
GCSE Mathematics
Number 1 – Structure and Calculations

DEFINITIONS

1	**Integer**	A whole number		
2	**Positive**	A number greater than zero		
3	**Negative**	A number less than zero		
4	**Decimal**	A number with digits after the decimal point		
5	**Operations**	Symbols and words used to show how to combine numbers		
		× Multiply + Add ÷ Divide – Subtract		
6	**Inverse Operations**	The operation used to reverse the original operation.		
		+ and - are inverses	× and ÷ are inverses	
7		Finding a square root is the inverse of finding the square		
8		Finding a cube root is the inverse of finding the cube		
9	**Order of Operations**	The order in which operations should be done	B I DM AS	Brackets Indices Divide and Multiply Add and Subtract
10	≠	Not equal to		
11	**Inclusive**	The end numbers are included		
12	**Index Form**	A number written to a power of an index		
13	**Prefix**	Is the beginning of a word		
14	**Standard Form**	A number written in the form $A \times 10^n$ Where $1 \leq A < 10$ and n is an integer		
15		Large number	$4.3 \times 10^6 = 4300000$	
16		Small number	$2.1 \times 10^{-3} = 0.0021$	
17	**Scientific Notation**	Another name for Standard Form		
18	**Surd**	A surd is a number written exactly using square or cube roots e.g. $\sqrt{3}$ is a surd, $\sqrt{4}$ is not a surd because it is 2		
19	**Fraction**	Represents part of a whole number	e.g. $\frac{4}{5}$	
20	**Numerator**	the number on the top of a fraction	$\frac{numerator}{denominator}$	
21	**Denominator**	the number on the bottom of a fraction		

22	**Rationalise the denominator**	Means remove the surd from the bottom of a fraction	
23	**Factor**	A factor is a number that divides into another number. eg factors of 6: 1, 2, 3 and 6	
24	**Multiple**	A multiple is a number from the times tables eg the first five multiples of 4: 4, 8, 12, 16 and 20	
25	**Prime number**	A prime number is a number with exactly 2 factors	
		2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97	
26	**Product**	The answer when two or more numbers are multiplied together.	
27	**Prime factor decomposition**	Writing a number as a **product of its prime factors**	
28	**Highest common factor (HCF)**	The highest number that divides exactly into two or more numbers. eg The HCF of 12 & 8 is 4	
29	**Lowest common multiple (LCM)**	The smallest positive number that is a multiple of two or more numbers. eg The LCM of 12 & 8 is 24	
30	**Combinations**	When there are *m* ways of doing a task, and *n* ways of doing a second task, then the total number of combinations is *m* × *n*	

RULES OF INDICES

31	**Multiplying**	add the powers	$x^7 \times x^4 = x^{11}$
32	**Dividing**	subtract the powers	$x^9 \div x^3 = x^6$
33	**Brackets**	Multiply the powers	$(x^7)^2 = x^{14}$
34	**Power of 0**	Always = 1	$m^0 = 1$
35	**Negative**	Means "1 over"	$x^{-n} = \frac{1}{x^n}$
36	**Unit Fraction**	Means root	$x^{\frac{1}{n}} = \sqrt[n]{x}$
37	**Fractional**	Means root and bracket	$x^{\frac{m}{n}} = \left(\sqrt[n]{x}\right)^m$

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STANDARD FORM		
38	**Converting a small number into standard form**	0.00000037 = 3.7 x 10^{-7}
39	**Converting a very large number to standard form**	147 100 000 000 = 1.471 x 10^{11}
40	**Converting to a small ordinary number**	2.4 x 10^{-6} = 0.0000024
41	**Converting to a large ordinary number**	5.67 x 109 = 5 670 000 000
42	**Adding or subtracting numbers in standard form**	The numbers must be converted into the ordinary numbers $(2.3 \times 10^4) + (6.4 \times 10^3)$ $= 23000 + 6400$ $= 29400$ $= 2.94 \times 10^4$
43	**Multiplying numbers in standard form**	The format stays the same. We can use **index laws** to help us. $(1.5 \times 10^3) \times (3 \times 10^5)$ $= 4.5 \times 10^{3+5}$ $= 4.5 \times 10^8$
44	**Dividing numbers in standard form**	The format stays the same. We can use **index laws** to help us. $(2.5 \times 10^{11}) \div (5 \times 10^{13})$ $= 0.5 \times 10^{-2}$ $= 5 \times 10^{-3}$

SURDS			
45	**Multiply surds**	$\sqrt{a} \times \sqrt{a} = a$	
46	**Dividing**	$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$	
47	**Add and subtract surds**	$\sqrt{a} + \sqrt{b}$ Cannot simplify	But $\sqrt{a} + \sqrt{a} = 2\sqrt{a}$
		$\sqrt{a} + \sqrt{a} = 2\sqrt{a}$	$5\sqrt{a} - 2\sqrt{a} = 3\sqrt{a}$
48	**Simplify**	$\sqrt{50} = \sqrt{25 \times 2}$ $= \sqrt{25} \times \sqrt{2}$ $= 5 \times \sqrt{2}$ $= 5\sqrt{2}$	$\sqrt{50} + \sqrt{18} = 5\sqrt{2} + 3\sqrt{2}$ $= 8\sqrt{2}$
49	**Rationalise the denominator** – Ensure there are no irrational numbers in the denominator	$\frac{1}{\sqrt{7}} = \frac{1}{\sqrt{7}} \times \frac{\sqrt{7}}{\sqrt{7}} = \frac{\sqrt{7}}{7}$	$\frac{1}{5+\sqrt{2}} = \frac{1}{5+\sqrt{2}} \times \frac{5-\sqrt{2}}{5-\sqrt{2}}$ $= \frac{5-\sqrt{2}}{3}$

GCSE Mathematics

Number 2 – Fractions, Decimals and Percentages

DEFINITIONS			
1	**Fraction**	Part of a whole	
2	**Numerator**	the number on the top of a fraction	$\frac{Numerator}{Denominator}$
3	**Denominator**	the number on the bottom of a fraction	
4	**Equivalent Fractions**	Fractions which have the same value but look different	$\frac{1}{2} = \frac{3}{6} = \frac{10}{20}$
5	**Simplifying Fractions**	Divide numerator and denominator by HCF	$\frac{24}{30} = \frac{4}{5}$
6	**Fraction of an Amount**	Amount divided by the denominator then multiplied by the numerator.	$\frac{5}{7}$ of 42 42 ÷ 7 x 5 = 30
7	**Mixed Number**	A number made from integer and fraction parts	$1\frac{3}{8}$
8		Before multiplying, dividing, adding or subtracting, always change mixed numbers into Improper fractions	
9	**Improper Fraction**	A number made from integer and fraction parts	$1\frac{3}{8}$
10	**Compare Fractions**	Write them with a common denominator	
11	**Unit Fraction**	Has a numerator of 1	$\frac{1}{6}$
12	**Reciprocal**	The reciprocal of a number is one divided by the number.	Reciprocal of 7 is $\frac{1}{7}$
13		Dividing by a number is the same as multiplying by its reciprocal	÷2 is the same as $\times\frac{1}{2}$
14	**Terminating Decimal**	Decimals that can be written exactly.	0.38
15	**Recurring Decimal**	Decimals where one digit or a group of digits are repeated.	0.777…… $= 0.\dot{7}$ 0.803803…. $= 0.\dot{8}0\dot{3}$
16	**Simple Interest**	Interest is calculated as a percent of an original loan	
17	**Compound Interest**	When interest is calculated on both the amount borrowed AND any previous interest	
18	**Tax**	A financial charge placed on sales or savings by the government e.g. VAT	
13	**Loss**	Income minus all expenses, resulting in a negative value.	
14	**Profit**	Income minus all expenses, resulting in a positive value.	

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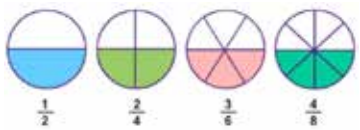
FRACTIONS			
19	**Equivalent fractions**		
20	**Finding equivalent fractions**	Multiply the numerator (top) and the denominator (bottom) by the same number. Here multiplying both by 5	$\frac{1}{2} = \frac{5}{10}$
21	**Multiply Fractions**	Multiply the numerators and multiply the denominators.	$\frac{6}{7} \times \frac{4}{5} = \frac{6 \times 4}{7 \times 5} = \frac{24}{35}$
22	**Divide Fractions**	Flip the second fraction (find the reciprocal). Change the divide to a multiply. Multiply the fractions	$\frac{4}{7} \div \frac{5}{6} = \frac{4}{7} \times \frac{6}{5} = \frac{4 \times 6}{7 \times 5} = \frac{24}{35}$
23	**Add or Subtract Fractions**	Write as fractions with a common denominator. Add or subtract the numerators.	$\frac{2}{8} + \frac{1}{6} = \frac{6}{24} + \frac{4}{24} = \frac{10}{24} = \frac{5}{12}$
24	**Convert between Improper and Mixed fractions**	Divide the numerator by the denominator. The answer gives the whole number part. The remainder goes on top of the fraction, with the same denominator.	$\frac{43}{6} = 7\frac{1}{6}$
25	**Convert between Mixed and Improper fractions**	Multiply the denominator by the whole number part and add the numerator. Put the answer over the numerator.	$7\frac{1}{6} = \frac{6 \times 7 + 1}{6} = \frac{43}{6}$

PERCENTAGES			
26	**Percentage**	Means "out of 100"	
27	**Percentage Increase**	Calculate the percentage and add it on to the original	
		Or use a multiplier	$\frac{100 + \%\ increase}{100}$
28	**Percentage decrease**	Calculate the percentage and subtract it from the original	
		Or use a multiplier	$\frac{100 - \%\ increase}{100}$
29	**Reverse Percentage**	Original Value x Multiplier = New Value Original Value = $\frac{\text{New Value}}{\text{Multiplier}}$	
30	**Compound Interest formula**	$P\left(1 + \frac{R}{100}\right)^n$	P – Original amount R – Interest rate n – the number of interest periods (e.g. yrs)
31		OR $Original \times Multiplier^{time}$	

CONVERSIONS		
32	**Percentage to Decimal**	Divide by 100
33	**Decimal to Percentage**	Multiply by 100
34	**Fraction to Percentage**	Find an equivalent fraction with 100 as the denominator
35	**Percentage to Fraction**	Write as a fraction over 100 and simplify
36	**Fraction to Decimal**	Division or convert to a % first
37	**Decimal to Fraction**	Use place value to find the denominator and simplify or convert to a % first

EQUIVALENT FRACTIONS, DECIMALS AND PERCENTAGES

38										
	Fraction	$\frac{1}{100}$	$\frac{1}{10}$	$\frac{1}{8}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{2}{3}$	$\frac{3}{4}$
	Decimal	0.01	0.1	0.125	0.2	0.25	$0.\dot{3}$	0.5	$0.\dot{6}$	0.75
	Percentage	1%	10%	12.5%	20%	25%	$33.\dot{3}\%$	50%	$66.\dot{6}\%$	75%

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GCSE Mathematics
Number 3 – Measures and Accuracy

DEFINITIONS

1	**Integer**	A whole number	
2	**Rounding**	Changing a number to a simpler, easy to use value	
3	**Approximate**	Not exact but close to the true answer	
4	**Decimal Place**	The number of digits after the decimal point	
5	**Significant Figure**	The digits of a number that express a size to a particular degree of accuracy	
6	**Estimation**	A value that is close to the correct answer using a rough calculation	
7	**Compound Measures**	Combine measures of two different quantities	
8	**Velocity**	Speed in a given direction	Usually measured in m/s
9	**Acceleration**	The rate of change of velocity	Usually measured in m/s^2

ROUNDING TO A SET NUMBER OF DECIMAL PLACES

10	Count the number of decimal places you need. Look at the number to the right of that digit 5 or more it rounds up 4 or less it rounds down			
11	eg 36.3486343	36.34|86343	To 2d.p. is 36.35	

ROUNDING TO SIGNIFICANT FIGURES

12	Count the number of digits you need from the left (zeros are not significant until after the first non-zero) Look at the number to the right of that digit to decide if it rounds up or down 5 or more it rounds up, 4 or less it rounds down (for large numbers replace remaining digits with zeros)			
13	eg 324 627 938	32 | 4627938	To 2 sig.fig. is 320 000 000	
14	eg 0.0034792	0.0034 | 792	To 2 sig.fig. is 0.0035	

ESTIMATING

15	Round each number to 1 significant figure before doing any calculations				
	eg $\frac{3.91 \times 8789.8}{620.9 \times 0.492}$	$\approx \frac{4 \times 9000}{600 \times 0.5}$	$\approx \frac{36000}{300}$	$\approx \frac{360}{3}$	≈ 120

COMPOUND MEASURES

16	**Density**	$density = \frac{mass}{volume}$	
17		The mass of a substance contained in a certain volume	
18		Usually measured in g/cm^3 or kg/m^3	
19	**Pressure**	$pressure = \frac{force}{area}$	
20		The force applied over an area	
21		Usually measured in N/m^2	
22	**Speed**	$speed = \frac{distance}{time}$	
23		The distance travelled in an amount of time	
24		Usually measured in m/s (metres per second) or km/h (kilometres per hour) or mph (miles per hour)	

UNITS ERRORS AND BOUNDS

25	**Area units**	1 cm^2 = 100 mm^2	1m^2 = 10000 cm^2
26	**Hectare**	An area of 10 000 m^2	
27	**Volume units**	1 cm^3 = 1000 mm^3	1 m^3 = 1000000 cm^3
28	**Capacity**	Is measured in *ml* and *litres*	1cm^3 = 1*ml*, 1000cm^3 = 1*litre*
29	**Error interval**	Measurements rounded to the nearest unit could be up to half a unit smaller or larger than the rounded value If x is 3.4 correct to 1 dp the error interval is $3.35 \le x < 3.45$	
30	**Truncation**	Approximating a decimal number by dropping all decimal places past a certain point without rounding	
31	**Upper Bound**	The upper bound is half a unit greater than the rounded number. If x = 13 to the nearest whole then the upper bound is 13.5	
32	**Lower Bound**	The lower bound is half a unit lower than the rounded number. If x = 14.8 correct to 1 dp then the lower bound of x is 14.75	
33	**Appropriate Accuracy**	The accuracy when both the upper bound and lower bound are rounded by the same amount and give the same value If UB = 12.3512 and LB = 12.3475 Rounded to 1dp: UB = 12.4, LB = 12.3 Rounded to 2dp: UB = 12.35, LB = 12.35 Rounded to 3dp: UB = 12.351, LB = 12.348 **So the appropriate accuracy is 2dp**	

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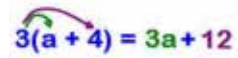
GCSE Mathematics
Algebra 1 – Notation, Vocabulary and Manipulation

DEFINITIONS		
1	**Variable**	A letter representing a varying or unknown quantity
2	**Coefficient**	A number which multiplies a variable. eg 3 is the coefficient in 3y
3	**Term**	A part of an algebraic expression, could be a number, a variable or a product of both.
4	**Like Terms**	Terms that have the same variable, but may have different coefficients eg $a + 3a$ are like terms $b + a + a^2$ are not like terms
5	**Expression**	One or a group of terms. May include variables, constants, operators and grouping symbols. No '=' sign
6	**Equation**	Expressions of equal value connected by an =
7	**Identity**	An equation that is true no matter what values are chosen, ≡
8	**Formula**	A rule describing a relationship between different variables
9	**Formulae**	Plural of Formula
10	**Substitute**	Replace a variable with a number
11	**Inverse Operation**	The operation that reverses the effect of another operation.
12	**Rearrange**	Change the position; move terms around
13	**Subject**	The subject of a formula is the variable on its own on one side of the equals sign
14	**Index**	A small number to the upper right of a base number that shows how many times the base is multiplied by itself
15	**Power**	Another word for an index
16	**Indices**	Plural of index
17	**Linear**	Can be represented by a straight line No indices above 1 eg $2x + 1$
18	**Quadratic**	An expression where the highest index is a 2 eg $3x^2 + 5x + 4$
19	**Expand**	Multiply out one or more brackets
20	**Factor**	A factor is a number **or variable** that divides into another number eg factors of $6x$: $1, 2, 3, 6$ *and* x
21	**Factorise**	Write an expression as a product of its factors The opposite of expanding out a bracket.

ALGEBRAIC NOTATION			
22	**Adding like terms**	Add the coefficients	$a + a = 2a$
23	**Subtracting like terms**	Subtract the coefficients	$5a - 3a = 2a$
24	**Multiplying like terms**	Add the powers	$a \times a = a^2$
25	**Dividing terms**	If the base is the same, subtract the powers	$a^5 \div a^2 = a^3$
26	**Adding different terms**	Cannot combine if the terms are different	$a + b = a + b$
27	**Subtracting different terms**	Cannot combine if the terms are different	$3a - 2b = 3a - 2b$
28	**Multiplying different terms**	Combine with no '×' sign	$a \times b = ab$
29	**Multiplying different terms with coefficients**	Combine with no '×' sign, multiply the coefficients	$3c \times 4a = 12ac$
30	**Dividing different terms**	Write as fractions with no '÷' sign	$3b \div a = \frac{3b}{a}$
31	**Dividing different terms with coefficients**	Write as fractions with no '÷' sign, simplify the coefficients if possible	$20c \div 4a = \frac{5c}{a}$
RULES OF INDICES			
32	**Multiplying**	Add the powers	$x^7 \times x^4 = x^{11}$
33	**Dividing**	Subtract the powers	$x^9 \div x^3 = x^6$
34	**Brackets**	Multiply the powers	$(x^7)^2 = x^{14}$
35	**Power of 0**	Always equal to 1	$m^0 = 1$
36	**Negative**	Means "1 over"	$x^{-n} = \frac{1}{x^n}$
37	**Unit Fraction**	n^{th} root	$x^{\frac{1}{n}} = \sqrt[n]{x}$
38	**Fractional**	n^{th} root to the power of m	$x^{\frac{m}{n}} = \left(\sqrt[n]{x}\right)^m$
EXPANDING SINGLE BRACKETS			
39	Multiply all of the terms inside the bracket, by the term on the outside		
40		$\begin{array}{c\|cc} & 3x & +1 \\ \hline 5 & 15x & +5 \end{array}$	$= 5x + 15$

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EXPANDING DOUBLE BRACKETS

41	Multiply every term in the first bracket by every term in the second bracket

42

FOIL

e.g. $(x+3)(x+4)$

FIRST	x^2
OUTER	$+4x$
INNER	$+3x$
LAST	$+12$

$x^2 + 4x + 3x + 12$
$= x^2 + 7x + 12$

GRID

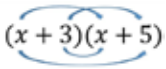
e.g. $(x+2)(x+7)$

	x	$+2$
x	$x2$	$+2x$
$+7$	$+7x$	$+14$

$x^2 + 2x + 7x + 14$
$= x^2 + 9x + 14$

SMILEY FACE

e.g. $(x+3)(x+5)$



$x^2 + 3x + 5x + 15$
$= x^2 + 8x + 15$

FACTORISING

43	Find the highest common factor of the terms This goes outside the bracket Divide each term by the factor to get the new terms inside the bracket.	eg $2x + 6$ HCF is 2 $= 2(\quad)$ $2x \div 2 = x$ $6 \div 2 = 3$ $= 2(x+3)$
44	CHECK by expanding your answer	$\begin{array}{c\|c\|c} & x & +3 \\ \hline 2 & 2x & +6 \end{array}$ $= 2x + 6$ ✓

FACTORISING QUADRATICS

45	**Factorising a quadratic**	Multiply to 5 Factorise $x^2 + 5x + 6$ ← Add to 6 2 and 3 add to 5 2 and 3 multiply to 6 $(x+2)(x+3)$ Check: $(x+2)(x+3) = x^2 + 5x + 6$
46	**Difference of two squares**	This is a quadratic equation with two squared terms, where one term is subtracted from the other eg $x^2 - 81 = (x+9)(x-9)$

SIMPLIFYING ALGEBRAIC FRACTIONS

47	If there is no obvious common factor then you should factorise both the numerator and the denominator and then cancel any common factors	
48	Adding and Subtracting	Common Denominator $\frac{a}{b} + \frac{c}{d} = \frac{ad}{bd} + \frac{bc}{bd} = \frac{ad+bc}{bd}$
49	Multiplying	$\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$
50	Dividing	$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$
51	Cancel common factors in the numerator and denominator	$\frac{(x-3)(x+2)}{(x+2)(x+5)} = \frac{x-3}{x+5}$

REARRANGING FORMULA

52	If the letter to be the subject appears twice then you will need to factorise		
53	Make u the subject: $v = u + at$ $(-\boldsymbol{at})$ $v - at = u$ So $u = v - at$	Make u the subject: $v^2 = u^2 + 2as$ $(-\boldsymbol{2as})$ $v^2 - 2as = u^2$ $(\sqrt{\quad})$ $\sqrt{v^2 - 2as} = u$ So $u = \sqrt{v^2 - 2as}$	Make m the subject: $I = mv - mu$ $(\boldsymbol{Factorise})$ $I = m(v-u)$ $(\div (\boldsymbol{v-u}))$ $\frac{I}{v-u} = m$ So $m = \frac{I}{v-u}$

PROOF

54	To show a statement is an identity, expand / factorise the expressions on one or both sides of the equal sign until they are the same	
55	**Proof**	A logical argument for a mathematical statement You must show it is true in ALL cases
56	**Counter-example**	To prove a statement is not true, you just have to find an example that does not fit the statement

FUNCTIONS

57	**Function**	A rule for working out values of y given values of x.	
58	**f(x)**	Notation – read as "f of x"	
59	**Composite functions**	$fg(x)$	To work out fg(x), first work out g(x), then substitute that answer into f(x)

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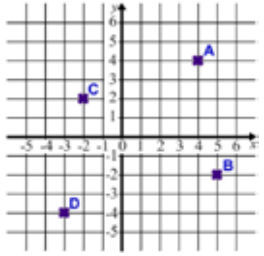
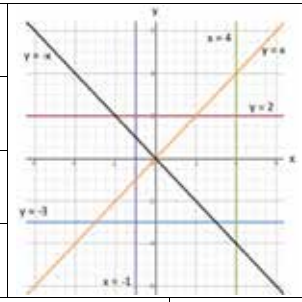
60	**Inverse functions**	$f^{-1}(x)$	Reverses the effect of the original function

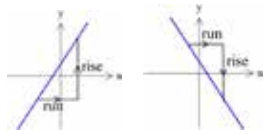
GCSE Mathematics
Algebra 2 - Graphs

DEFINITIONS

1	**Axis**	A reference line on a graph	
2	**Axes**	Plural of axis	
3	**Quadrant**	A quarter of a graph separated by axes	
4	**Origin**	The point (0, 0) on a set of axes	
5	**Coordinates**	Used to show a position on a coordinate plane	
		The first coordinate is the horizontal position (x axis), the second is the vertical position (y axis)	
6	**Parallel**	Equal distance apart If lines are extended, they will never meet.	
7	**'y =' graph**	Constant y co-ordinate	
		Will be parallel to the x-axis	
8	**'x =' graph**	Constant x co-ordinate	
		Will be parallel to the y-axis	
9	**y-intercept**	The y value where a graph crossed the y – axis.	where x = 0
10	**x-intercept**	The x value(s) where a graph crosses the x-axis.	where y = 0
11		A symbol on an axis to show that the axis has not started at zero	
12	**Trajectory**	The path an object follows	
13	**Asymptote**	A line that a graph will get very close to but never touch	
14	**Direct proportion**	- the graph is a straight line - that goes though the origin - if one variable is multiplied by n, so is the other	 A B C A is in direct B and C are not

15	**Gradient**	The steepness of a graph	
16	**Line segment**	A part of a line, has a start point, and an end point	
17	**Labelling a graph**	Means write the equation next to the line	
18	**Coefficient**	Number in front of a variable	
19	**Linear Equation**	Produces a straight line graph	
20	**Steady speed**	Means travelling the same distance each minute	
21	**Velocity**	Means speed in a particular direction	
22	**Rate of Change**	Shows how a variable changes over time	
23	**Sketch**	An approximate drawing of a graph using key points: roots, y-intercept, turning point	
24	**Iterative process**	A repeated process that can be used to find an accurate root of a quadratic or cubic equation	

STRAIGHT LINE GRAPHS

25	**Linear Equation**	A linear equation contains an x term but no higher power of x.	eg y = 3x – 1 2x + 3y = 8
26	**y = mx + c**	The general equation of a straight line	m is the gradient c is the y-intercept
27	**Gradient**	$Gradient = \frac{change\ in\ y}{change\ in\ x} = \frac{rise}{run}$	 This has a positive gradient This has a negative gradient
28		Positive gradients, line goes from bottom left to top right	
29		Negative gradients, line goes from top left to bottom right	
30	**Gradient between 2 points**	If A = (x_1, y_1) and B = (x_2, y_2) The gradient of line AB = $\frac{y_2-y_1}{x_2-x_1}$	
31	**Parallel lines**	Parallel lines have the same gradient	
32	**Perpendicular lines**	When lines are perpendicular the product of the gradients is – 1	
		If one graph has gradient m, then a perpendicular graph has gradient $-\frac{1}{m}$	
33	**Mid-point**	The mid-point is the coordinate half between two points.	If A = $(x_1,\ y_1)$ and B = $(x_2,\ y_2)$ the mid-point is $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$

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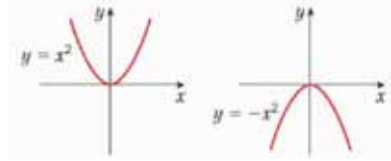
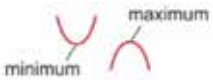
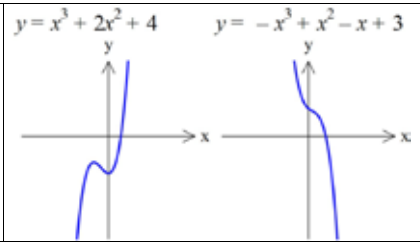
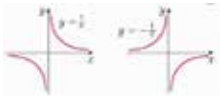
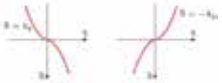
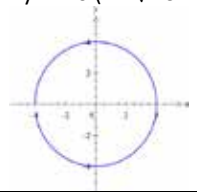
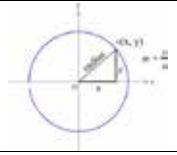
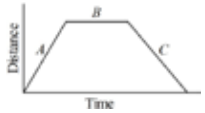
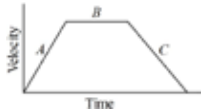
QUADRATIC GRAPHS			
34	The quadratic graph a curved shape called a parabola $y = ax^2 + bx + c$		
35	A positive x^2 term will give a ∪ shape		
36	A negative ($-x^2$) term will give a ∩ shape		
37	**Turning points**	The point where a curve turns in the opposite direction	
		Either a maximum or a minimum point	
38	**Line of symmetry**	A quadratic graph will have a line of symmetry passing through its maximum or minimum point	
39	**Roots**	Solution to the quadratic equation $ax^2 + bx + c = 0$	
40		The x-values where the graph crosses the x-axis	
41		A quadratic equation can have 0, 1, or 2 solutions	

CUBIC GRAPHS		
42	$y = ax^3 + bx^2 + cx + d$ Will have 1, 2, or 3 roots	

OTHER FUNCTIONS			
43	**Reciprocal functions**	Reciprocal graphs have the form $y = \frac{k}{x}$ where k is a number	
44		It will have 2 asymptotes	
45	**Maximum and minimum points**	A quadratic graph has a maximum point or minimum point where the graph turns.	
46	**Cubic functions**	A cubic function contains an x^3 but no higher power of x. It can have an x^2 and x term	
47		A cubic equation can have 1, 2, or 3 solutions	

GRAPHS OF CIRCLES			
48	**Equation of a circle**	Circle with a centre of (0, 0) and radius r $x^2 + y^2 = r^2$	. $x^2 + y^2 = 16$ ($r = \sqrt{16} = 4$) 
49	**Gradient between 2 points**	If A = (x_1, y_1) and B = (x_2, y_2) The gradient of line AB $m = \frac{y_2 - y_1}{x_2 - x_1}$	
50	**Perpendicular lines**	When lines are perpendicular the product of the gradients is – 1. If one graph has gradient m, the other has gradient $-\frac{1}{m}$	
51	**Gradient of a radius to a circle**	The gradient (m) of a radius to a point (x, y) on the circle $x^2 + y^2 = r^2$ is $\frac{y}{x}$	

DISTANCE – TIME GRAPHS		
52	Represent a journey	 A = steady speed, B = no movement, C = steady speed back to start
53	The vertical axis represents the distance from a starting point	
54	The horizontal axis represents time taken	
55	Straight lines mean constant speed	
56	Horizontal lines mean no movement	
57	Gradient = speed	
58	$Average\ speed = \frac{Total\ distance}{Total\ time}$	

VELOCITY – TIME GRAPHS		
59	Represent the speed at a given time	 A = steady acceleration, B = constant speed, C = steady deceleration back to a stop
60	Straight lines mean constant acceleration/deceleration	
61	Horizontal lines mean no change in velocity (speed)	
62	Positive Gradient = acceleration	
63	Negative Gradient = deceleration	
64	The area under the graph = distance travelled	

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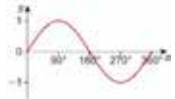
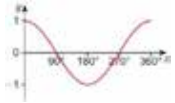
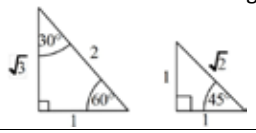
TRIGONOMETRICAL GRAPHS			
65	**Sine function**	The sine graph repeats every 360° in both directions.	
66	**Cosine function**	The cosine graph repeats every 360° in both directions.	
67	**Tangent function**	The tangent graph repeats every 180° in both directions. The tangent graph is not defined for angles of the form (90° ± 180n°)	
68	**Exact trigonometrical values**		

Θ	0°	30°	45°	60°	90°
Sin Θ	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
Cos Θ	1	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0
Tan Θ	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	

These can be found using the triangles:



TRANSFORMING GRAPHS		
69	***y* = –f(*x*)**	The graph of the reflection of the graph y = f(x) in the x-axis
70	***y* = f(–*x*)**	The graph of the reflection of the graph y = f(x) in the y-axis
71	***y* = -f(-*x*)**	The graph of the reflection of the graph y = f(x) in the x-axis, and then in the y-axis
72		Equivalent to a rotation 180˚ about the origin
73	***y* = f(*x*) + a**	The graph of the translation of the graph y = f(x) by $\begin{pmatrix} 0 \\ a \end{pmatrix}$
74	***y* = f(x + a)**	The graph of the translation of the graph y = f(x) by $\begin{pmatrix} -a \\ 0 \end{pmatrix}$
75	***y* = af(*x*)**	The graph is a vertical stretch of the graph y = f(x), with a scale factor a, parallel to the y-axis
76	***y* = f(a*x*)**	The graph is a horizontal stretch of the graph y = f(x), with a scale factor $\frac{1}{a}$, parallel to the x-axis

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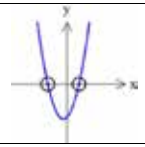
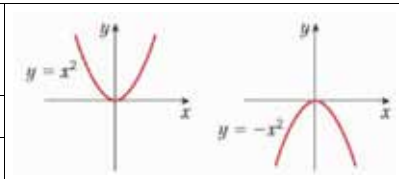
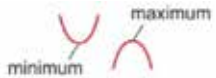
GCSE Mathematics
Algebra 3 – Solving Equations and Inequalities

DEFINITIONS			
1	**Integer**	Whole number	
2	**Term**	One part of an algebraic expression which may be a number, a variable or a product of both.	e.g. 3x
3	**Expression**	An expression is one or a group of terms and may include variables, constants, operators and grouping symbols	e.g. 5x + 2y
4	**Equation**	A mathematical statement containing an equals sign (=), to show that two expressions are equal.	e.g. 3x + 4 = x - 2
5	**Formula**	A special type of equation that shows the relationship between different variables	
6	**Identity**	An equation which is always true regardless of the value of the variables. Has an identity sign (Ξ)	e.g. 3(x + 5) Ξ 3x + 15
7	**Unknown**	A letter representing a number	
8	**Subject**	The subject of a formula is the variable on its own on one side of the equals sign	
9	**Inverse Operation**	The operation that reverses the effect of another operation.	
10	**Solve**	To find the value of the unknown	
11	**Quadratic equation**	An equation with 2 as the highest power of the unknown	e.g. $3x^2 - 5 = 43$, $x^2 - 3x + 2 = 0$
12	**Solving quadratic equations**	Finding the values for the unknown that balance the equation	
13	**Roots**	Solution to the quadratic equation $ax^2 + bx + c = 0$	
14		The x-values where the graph crosses the x-axis	
15		A quadratic equation can have 0, 1, or 2 solutions	
16	**Simultaneous Equations**	When there are two equations each with two unknowns	
17	**Inequality**	> Is greater than	≥ Is greater than or equal to
18		< Is less than	≤ Is less than or equal to
19	**Inclusive**	Gives a finite range of solutions	e.g. 3 ≤ x < 7
20	**Exclusive**	Gives an infinite range of solutions	e.g 4 < x x< 1
21	**Region**	The area on a graph where all points that satisfy one or more inequalities can be found	
22	**Inequalities using set notation**	A set of values that satisfy an inequality described using set notation	$\{x : x > 3\} \cup \{x < -2\}$ or $\{x : -2 \le x \le 3\}$
SOLVING EQUATIONS			
23	To solve an equation we use inverse operations		
24	What ever you do to one side of the equation, you have to do to the other side to keep it "balanced" and equal		
25	**One step**	Solving equations – one step	

$x + 4 = 7$	$x - 5 = 12$	$3x = 18$	$\frac{x}{4} = 6$
$(-4) \quad (-4)$	$(+5) \quad (+5)$	$(\div 3) \quad (\div 3)$	$(\times 4) \quad (\times 4)$
$x = 11$	$x = 17$	$x = 1$	$x = 24$

26	**Two step**	Requires two inverse operations to solve	$2x - 7 = 19$ $2x = 26$ $x = 13$
27	**Involving brackets**	Expand the brackets first	$5(2x + 1) = 35$ $10x + 5 = 35$ $10x = 30$ $x = 3$
28	**Unknowns both sides**	Eliminate the x term from one of the sides	$5x + 2 = 3x - 8$ $2x + 2 = -8$ $2x = -10$ $x = -5$
SOLVING QUADRATIC EQUATIONS			
29	The quadratic graph a curved shape called a parabola $y = ax^2 + bx + c$		
30	A positive x^2 term will give a ∪ shape		
31	A negative ($-x^2$) term will give a ∩ shape		
32	**Turning points**	The point where a curve turns in the opposite direction	
		Either a maximum or a minimum point	
33	**Line of symmetry**	A quadratic graph will have a line of symmetry passing through its maximum or minimum point	
34	**Roots**	Solution to the quadratic equation $ax^2 + bx + c = 0$	
35		The x-values where the graph crosses the x-axis	
36		A quadratic equation can have 0, 1, or 2 solutions	

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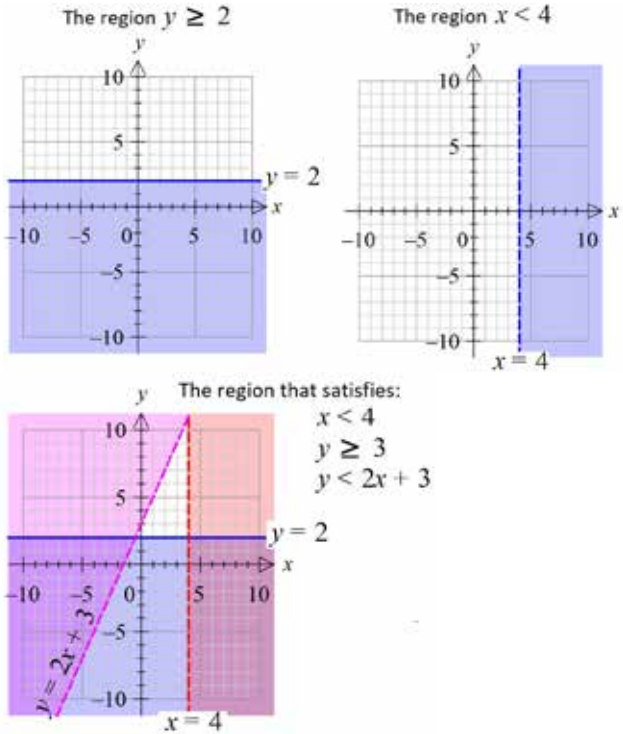
37	**Solving Quadratics**	Quadratics equations can be solved to find the roots	
		The roots are where the quadratic graph intersects the x-axis	
		There are three ways to solve quadratics: 1. Factorising 2. The Quadratic Formula 3. Completing the Square	
38	**By Factorising**	Writing the equation as the product of two linear expressions to find the solution	e.g. Solve $2x^2 - 3x - 2 = 0$ $(2x+1)(x-2) = 0$ So $2x + 1 = 0$ or $x - 2 = 0$ $x = -\frac{1}{2}$ or $x = 2$
39	**By Quadratic Formula**	A formula that can be used to work out the solutions to the quadratic equation $ax^2 + bx + c = 0$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	e.g. Solve $x^2 + 4x + 2 = 0$ $a = 1, b = 4, c = 2$ $x = \frac{-4 \pm \sqrt{4^2 - 4 \times 1 \times 2}}{2 \times 1}$ Giving $x = -0.59$ and $x = -3.41$ as the solutions
40	**By Completing the square**	$x^2 + bx + c$ can be written in the form $\left(x + \frac{b}{2}\right)^2 - \left(\frac{b}{2}\right)^2 + c$	e.g. $x^2 + 6x + 7$ The completed square is $(x+3)^2 - 3^2 + 7$ $= (x+3)^2 - 2$
SOLVING SIMULTANEOUS EQUATIONS			
41	**Elimination**	Add or subtract one equation from the other to eliminate a variable ✓ Same ✓ Subtract ✓ Substitute	
42	**Substitution**	Rearrange so that the subject of one equation is a single variable, then substitute into the second equation	
43	**Graphically**	A pair of quadratic and linear simultaneous equations can have 2 possible solutions	
44		To find the coordinates where two graphs intersect, solve their equations simultaneously	

INEQUALTITIES			
45	**Solve**	Inequalities are solved using the same steps as equations.	
46	**List integer solutions**	Give the integers that satisfy the inequality eg $x > 5$ integer solutions are 6, 7, 8 …… eg $3 \le x < 7.4$ integer solutions are 3, 4, 5, 6, 7	
47	**Represent on a number line**	An empty circle shows the value is NOT included	○
		A full circle shows the value IS included	●
		An arrow shows the solution continues to infinity	○→
48	**Negative multiples**	If you multiply or divide an inequality by a negative number, then the inequality sign is reversed	
LINEAR INEQUALITIES			
49	Points that satisfy an inequality can be represented on a graph		
50	The unwanted sections are shaded  		
51	Dashed line for exclusive (< or >)	Solid line for inclusive (≥ or ≤)	

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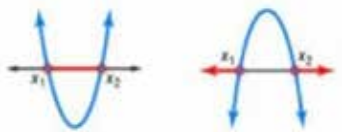
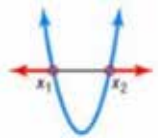
QUADRATIC INEQUALITIES		
52		To solve $ax^2 + bx + c < 0$ identify the values of x for which the graph lies **BELOW** the x-axis
53		To solve $ax^2 + bx + c > 0$ identify the values of x for which the graph lies **ABOVE** the x-axis

ITERATIONS		
54	**Iteration**	is the act of repeating a process, either to generate an unbounded sequence of outcomes, or with the aim of approaching a desired goal, target or result
55	**Iterative Sequence**	defined by giving the relationship between consecutive terms, e.g. The relationship, $x_{n+1} = x_n - 3$, is said to produce an iterative sequence.
56	**Roots**	Solutions to an equation. Where the graph crosses the x-axis
57	**Change of sign**	Show two values with a root between them

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GCSE Mathematics
Algebra 4 - Sequences

DEFINITIONS

1	**Integer**	A whole number
2	**Sequence**	an ordered pattern of numbers or diagrams
3	**Series**	The sum of the terms in a sequence
4	**Term**	One of the numbers in a sequence
5	**Term-to-term rule**	the rule for moving from one number in a sequence to the next number e.g. 4 7 10 ……. Term-to-term rule is + 3
6	**Arithmetic sequence**	a sequence where the term to term rule is to add or subtract the same amount each time e.g. 3, 7, 11, 15, 19, 23, …
7	**Geometric sequence**	A sequence where the term to term rule is to multiply by the same amount each time e.g. 3, 6, 12, 24, 48, …
8	**Common Ratio**	The amount a geometric sequence is multiplied by from one term to the next
9	**Quadratic Sequence**	A sequence where the term to term rule is changing by the same amount each time. The second difference is a constant amount
10	**Difference**	Means subtract
11	**Position to term**	the rule for finding any value of a sequence
12	**nth term for an Arithmetic sequence**	The rule to find any term in a sequence of numbers - Find the common difference between the terms - This is your coefficient of n - The number needed to add or subtract to get to the first term is the 2nd term in the rule

0	1	2	3	4	5
3n + 1	**4**	**7**	**10**	**13**	**16**

+3 +3 +3 +3

3n	3	6	9	12	15

13	**n^{th} term for a Geometric sequence**	Divide the second sequence by the first to find the common ratio The nth term is ar^{n-1} where a is the first term, r is the common ratio and n is the term position in the sequence
14	**n^{th} term for a Quadratic sequence**	Find the first difference Find the second difference Halve this value and multiply by n^2 to gain a new sequence an^2 Subtract the new sequence from the original sequence. Find the nth term of the remaining sequence $bn + c$ The nth term is then $an^2 + bn + c$
15	**Finite**	Has a final point
16	**Infinite**	Continues forever
17	**Ascending**	Increases
18	**Descending**	Decreases
19	**Formula**	A rule written to describe a relationship between quantities.
20	**Multiple**	A number from the times tables e.g. the first five multiples of 4 are 4, 8, 12, 16 and 20
21	**Linear function**	An arithmetic sequence that can be represent by a straight line graph

SPECIAL SEQUENCES

22	**Square numbers**	1, 4, 9, 16, 25, 36 …	
23	**Cube numbers**	1, 8, 27, 64, 125 …..	
24	**Triangular numbers**	1, 3, 6, 10, 15, 21, 28 ….	O O O O O O O O O O O O O O O
25	**Fibonacci Sequence**	A sequence where each term is the sum of the two previous terms e.g. 1, 1, 2, 3, 5, 8, 13, 21, …	

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GCSE Mathematics
Ratio and Proportion

DEFINITIONS		
1	**Ratio**	A relationship between two or more quantities
2	**Proportion**	Compares a part with the whole, i.e. fraction
3	**Fraction**	Used to indicate a part of a whole number
4	**Share**	Splitting into parts not necessarily equally but in a predefined ratio
5	**Unit Ratio**	Used to compare ratios, one of the parts is 1
		The only time it is permissible to have a decimal in a ratio
6	**Proportional**	a change in one is always accompanied by a change in the other,
7	**Unitary Method**	Find the value of 1 item, before multiplying to find the value of more
		Used to work out which products give the better value for money
8	**Exchange Rate**	The amount of money in a different currency that your currency will buy or sell for
9	**Equivalent**	Ratios are equivalent if they have the same simplest form
10	**Function**	a relation or expression involving one or more variables
11	**Direct proportion**	Two quantities increase at the same rate
12	**Inverse proportion**	One variable increases at a constant rate as the second variable decreases
13	**Graphical**	Referring to a graph
14	**Linear**	An equation that produces a straight line graph
15	**Annual**	Means yearly
16	**Per annum**	Means per year
17	**Salary**	A fixed regular payment, often paid monthly
18	**Simple Interest**	Interest is calculated as a percent of an original loan
19	**Compound Interest**	When interest is calculated on both the amount borrowed AND any previous interest
20	**Half - Life**	The time taken for the count rate to fall to half its starting value
21	**Tax**	A financial charge placed on sales or savings by the government e.g. VAT
22	**Loss**	Income minus all expenses, resulting in a negative value.

23	**Profit**	Income minus all expenses, resulting in a positive value.	
24	**Compound Measures**	Combine measures of two different quantities	
25	**Velocity**	Speed in a given direction	Usually measured in m/s
26	**Acceleration**	The rate of change of velocity	Usually measured in m/s^2
27	**Rest**	If something "starts from rest" it means its initial velocity is zero	
RATIO			
28	**Simplifying Ratio**	Divide each part of the ratio by a common factor	eg 12:18 simplifies to 2:3
29	**Simplest Form**	Divide each part of the ratio by the highest common factor, so it cannot reduce further	
		All parts must be integers	
30	**Divide in a given ratio**	Divide an amount so the ratio of the final values simplifies to the given ratio.	eg Divide £350 in the ratio 3:4 between Amy and Bob. 3+4 = 7 (There are 7 parts.) 350 ÷ 7 = 50 (Each part is worth 50) 3 x 50 = £150 for Amy 4 x 50 = £200 for Bob

PERCENTAGES		
31	The **original amount** is always 100%	If you increase, the new amount will be more than 100%
		If you decrease, the new amount will be less than 100%
32	**Express one number as a percentage of another**	$\frac{Number\ 1}{Number\ 2} \times 100$
33	**Percentage change**	$\frac{Change}{Original} \times 100$
34	**To find a multiplier for an increase**	$\frac{100 + \%\ increase}{100}$
35	**To find a multiplier for a decrease**	$\frac{100 - \%\ decrease}{100}$
COMPOUND INTEREST FORMULA		
36	$P\left(1 + \frac{R}{100}\right)^n$	P – Original amount R – Interest rate n – the number of interest periods (e.g. years)
37	**or**	$Original \times Multiplier^{time\ period}$

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COMPOUND MEASURES			
38	**Density**	$density = \frac{mass}{volume}$	
39		The mass of a substance contained in a certain volume	
40		Usually measured in g/cm^3 or kg/m^3	
41	**Pressure**	$pressure = \frac{force}{area}$	
42		The force applied over an area	
43		Usually measured in N/m^2	
44	**Speed**	$speed = \frac{distance}{time}$	
45		The distance travelled in an amount of time	
46		Usually measured in m/s (metres per second) or km/h (kilometres per hour) or mph (miles per hour)	

KINEMATICS		
47	$\boldsymbol{v = u + at}$	*a* is constant acceleration *u* is initial velocity *v* is final velocity *t* is the time taken *s* is the displacement from the position when *t*=0
48	$\boldsymbol{s = ut + \frac{1}{2}at^2}$	
49	$\boldsymbol{v^2 = u^2 + 2as}$	

PROPORTION			
50	**Directly Proportional graph**	The graph of two quantities in direct proportion will go through the origin and have a positive gradient	
51	**Direct proportion**	- the graph is a straight line - that goes though the origin - if one variable is multiplied by n, so is the other	 A B C A is in direct B and C are not
52	**Constant of proportionality**	Represented by a *k*	Its value stays the same
53	**Direct proportion**	Two quantities increase at the same rate	"*y* is proportional to *x*" $y \propto x$ $y = kx$
54	**Indirect Proportion**	One variable increases at a constant rate as the second variable decreases	"*y* is inversely proportional to *x*" $y \propto \frac{1}{x}$ $y = \frac{k}{x}$

RATE OF CHANGE		
55	**Rate of Change**	The gradient of a tangent to the curve can be used to calculate the rate of change at any given point.

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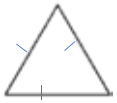
GCSE Mathematics
Geometry 1 – Properties and Construction

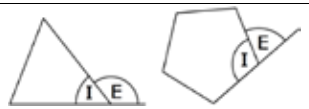
SPECIAL QUADRILATERALS (4 sided polygon) - Properties

1	**Square**		4 equal sides 4 right angles 2 pairs of parallel sides Diagonals cross at right angles	4 lines of symmetry Rotational symmetry order 4
2	**Rectangle**		2 pairs of equal sides 4 right angles 2 pairs of parallel sides	2 lines of symmetry Rotational symmetry order 2
3	**Rhombus**		4 equal sides 2 pairs of equal angles 2 pairs of parallel sides Diagonals cross at right angles	2 lines of symmetry Rotational symmetry order 2
4	**Parallelogram**		2 pairs of equal sides 2 pairs of equal angles 2 pairs of parallel sides	0 lines of symmetry Rotational symmetry order 2
5	**Kite**		2 pairs of equal sides 1 pairs of equal angles 2 pairs of parallel sides Diagonals cross at right angles	1 lines of symmetry Rotational symmetry order 1
6	**Trapezium**		1 pair of parallel sides	
7	**Isosceles Trapezium**		1 pair of parallel sides 1 pair of equal sides 2 pairs of equal angles	1 lines of symmetry Rotational symmetry order 1

SPECIAL TRIANGLES (3 sided polygon)

8	**Equilateral**		- 3 equal sides - 3 equal angles (60˚)	- 3 lines of symmetry - Rotational symmetry order 3
9	**Isosceles**		- 2 equal sides - 2 equal angles	- 1 line of symmetry - Rotational symmetry order 1
10	**Scalene**		- No equal sides - No equal angles	
11	**Right-angled**		- 1 right angle - Can be scalene or isosceles	

DEFINITIONS - ANGLES

12	**Protractor**	Equipment used to measure the size of an angle	
13	**Angle**	a measure of turn, measured in degrees ^{o}	
14	**Acute angle**	An angle less than 90°	
15	**Right angle**	A 90° angle	
16	**Obtuse angle**	An angle more than 90° but less than 180°	
17	**Reflex Angle**	An angle of more than 180°	
18	**Parallel lines**		Equal distance apart If lines are extended, they will never meet.
19	**Interior angles (I)**	I is the interior angle which is inside the polygon	
20	**Exterior angles (E)**	E is the exterior angle which is outside the polygon	For any polygon: I + E = 180°
21	**Polygon**	A 2D shape with straight sides only	
22	**Regular Polygon**	All sides the same length All angles the same size	
23	**Congruent**	Two shapes are congruent when they are exactly the same shape and size	
24	**Similar**	same shape but different sizes	
25	**A Diagonal**	A line which joins opposite vertices of a shape	
26	**Bisect**	Cut in half	
27	**Tessellate**	Fit together leaving no gaps	

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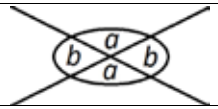
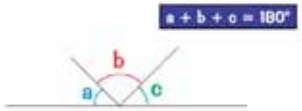
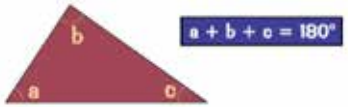
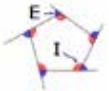
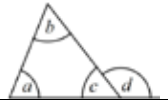
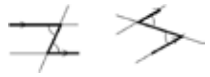
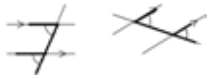
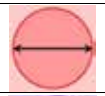
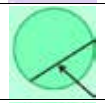
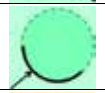
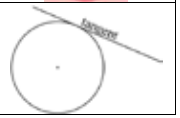
ANGLE RULES		
28	**Vertically Opposite angles are equal**	
29	**Angles on a straight line add up to 180**	
30	**Angles in a triangle add up to 180°**	
31	**Angles around a point add up to 360°**	
32	**Angles in a quadrilateral add up to 360°**	

ANGLES IN POLYGONS			
33	**Interior Angles (I) Exterior angles (E)**	Interior angle + Exterior angle = 180˚ (as on a straight line) 	
34	**Exterior angle in a triangle**	The exterior angle of a triangle equals the sum of the two opposite interior angles. angle d = angle a + angle b	
35	**Sum of interior angles**	For an n-sided polygon Sum of interior angles = $180 \times (n - 2)$ The sum can also be found by splitting the polygon into triangles and multiplying the number of triangles by 180	
36	**Sum of exterior angles**	For all polygons: Sum of exterior angles = 360	
37	**Regular polygons**	$Exterior\ angle = 360 \div number\ of\ sides$	
		$number\ of\ sides = 360 \div Exterior\ Angle$	
		$Interior\ angle = 180 - Exterior\ angle$	

ANGLES ON PARALLEL LINES			
38	**Alternate angles**	Alternate angles on parallel lines are equal Alternate angles form a 'Z' shape	
39	**Corresponding angles**	Corresponding Angles on parallel lines are equal. Corresponding angles form an 'F' shape	
40	**Co-interior angles**	Co-interior angles add to 180 degrees. Co-interior angles form a 'C' or 'U' shape	

DEFINITIONS - CIRCLES			
41	**Diameter**	A chord that passes through the centre of a circle	
42	**Radius**	The distance from the centre to the circumference of a circle	
43	**Radii**	Plural of radius	
44	**Diameter**	Distance from edge to edge passing through the centre.	
45	**Circumference**	Distance around the outside of a circle. (The perimeter)	
46	**Chord**	A line which touches the circumference at each end	
47	**Arc**	A section from the circumference of a circle	
48	**Segment**	The region of a circle bounded by a chord and the arc subtended by the chord	
49	**Sector**	The region of a circle bounded by two radii and an arc	
50	**Tangent**	A line outside a circle which only touches the circumference at one point	

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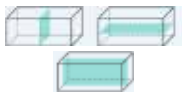
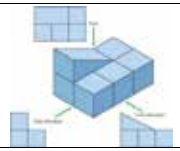
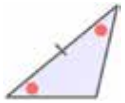
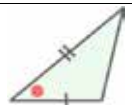
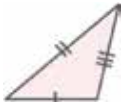
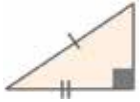
51	**Semi-circle**	Half a circle	
52	**π (Pi)**	The constant ratio between the circumference and the diameter of circles.	3.14159265……
53	**Formula**	Shows the relationship between different variables	
54	**Formulae**	Plural of Formula	
55	**Substitute**	Replace a variable with a number	
56	**Pyramid**	A 3D shape with a polygon as a base and triangular sides that meet at the top	
57	**Sphere**	A 3D shape where all the points on the surface are the same distance from the centre	
58	**Spherical**	Means in the shape of a sphere	
DEFINITIONS – 3D SOLIDS			
59	**Face**	A flat surface of a 3D shape (can be curved)	
60	**Edge**	A line segment where 2 faces meet	
61	**Vertex**	A point where 2 or more edges meet	
62	**Vertices**	Plural of vertex	
63	**Pyramid**	3D shapes which have a base of any shape, and sloping sides which meet at a point	
64	**Dimension**	A dimension is the size of something in a particular direction e.g. length, width, height, diameter	
65	**Plane**	A flat 2D surface	
66	**Plane of symmetry**	When a solid can be cut exactly in half, and a part on one side of the plane is an exact reflection of the part on the other side of the plane	
67	**Plan**	The view from above a solid	
68	**Front Elevation**	The view from the front of a solid	
69	**Side Elevation**	The view from the side of a solid	
70	**Scale**	A scale is a ratio that shows the relationship between a length on a drawing or a map and the actual length.	

DEFINITIONS – LOCI AND CONSTRUCTIONS			
71	**Construct**	Draw accurately using a ruler and a pair of compasses	
72	**Construction lines**	Working out lines / arcs are called construction lines	
73		Must not be rubbed out – they show the 'working out'	
74	**Cyclical Quadrilateral**	A four sided polygon whose vertices are all on the circumference of a circle	
75	**Bisect**	Cut in half	
76	**Perpendicular**	At right angles	
77	**Perpendicular bisector**	The line that cuts another in half at right angles	
78	**Angle bisector**	The line that cuts an angle exactly in half	
79	**Locus**	The set of all points that obey a certain rule. This is often drawn as a continuous path	
80	**Loci**	The plural of locus	
81	**Region**	An area bounded by loci	
DRAWING ACCURATE TRIANGLES			
82	**ASA**	Given angle, side, angle you can draw an accurate triangle	
83	**SAS**	Given two sides and the angle in between you can draw an accurate triangle	
83	**SSS**	Given all three sides you can draw an accurate triangle	
84	**RHS**	Given that it has a right angle, the hypotenuse and another side length, you can draw an accurate triangle	

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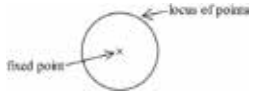
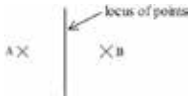
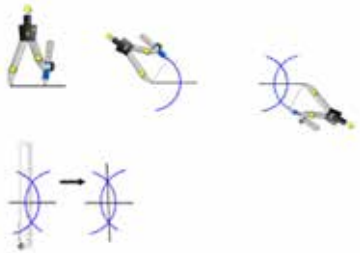
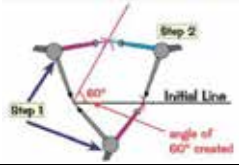
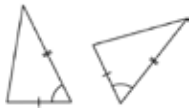
LOCI			
85	**Locus 1: Circle**	The locus of points that are a fixed distance from a fixed point	
86	**Locus 2: parallel line**	The locus of points a fixed distance from a fixed line	
87	**Locus 3: Perpendicular bisector**	The line that cuts another in half at right angles	
88	**Locus 4: angle bisector**	The locus of points equidistant between two fixed points	
CONSTRUCTIONS			
88	**Angle Bisector**		
89	**Perpendicular Bisector**		
90	**Constructing 60^0 angles**		

DEFINITIONS – SIMILARITY AND CONGRUENCE			
91	**Congruent**	Exactly the same shape and size	
92	**Similar**	Same shape but different sizes	
CONGRUENT TRIANGLES			
93	Triangles are congruent when one of the 4 conditions of congruence is true		
94	**SSS**	Two triangles are congruent if all 3 sides are equal	
95	**SAS**	Two triangles are congruent if two sides and the included angle are equal	
96	**AAS**	Two triangles are congruent if two angles and the corresponding side are equal	
97	**RHS**	Condition 4: Two triangles are congruent if right angle, hypotenuse and one other side are equal	

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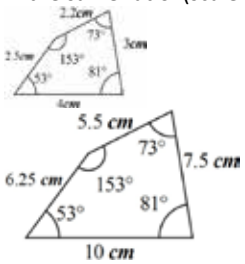
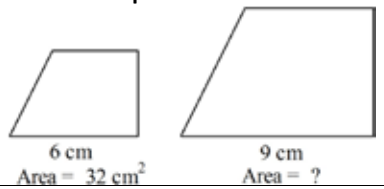
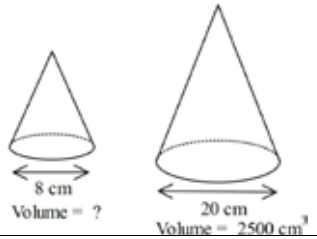
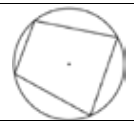
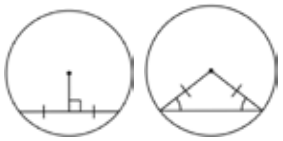
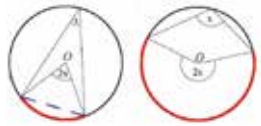
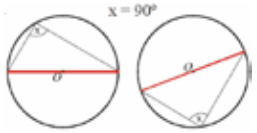
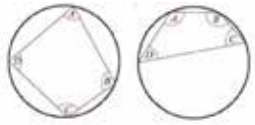
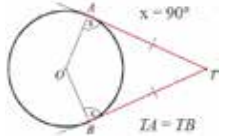
SIMILARITY			
98	Similar shapes	Two shapes where one shape is an enlargement of the other. Corresponding angles are equal and corresponding sides are all in the same ratio (scale factor) 	Small base = 4cm Large base = 10cm Ratio of these corresponding sides is $10 : 4 = 2.5 : 1$ Scale factor $= 2.5$ Or $\frac{length\ from\ large\ shape}{length\ from\ small\ shape}$ $= \frac{10}{4} = 2.5$
99	**Linear scale factor (LSF)**	The scale factor or ratio of sides of two similar shapes.	$LSF = \frac{length\ from\ large\ shape}{length\ from\ small\ shape}$
100		If the LSF is k lengths are multiplied or divided by k	
101	**Area scale factor (ASF)**	The scale factor or ratio of areas or surface areas of two similar shapes	$ASF = \frac{area\ from\ large\ shape}{area\ from\ small\ shape}$
102		If the LSF is k the areas are multiplied/divided by k^2	
103	**Volume scale factor (VSF)**	The scale factor or ratio of volumes of two similar shapes.	$VSF = \frac{volume\ from\ large\ shape}{volume\ from\ small\ shape}$
104		If the LSF is k the areas are multiplied/divided by k^3	
105	**Area of similar shapes** 		LSF = $\frac{9}{6} = 1.5$ ASF = 1.5^2 = 2.25 Area of large shape = 2.25 x 32 = 72 cm^2
106	**Volume of similar shapes** 		LSF = $\frac{20}{8} = 2.5$ VSF = 2.5^2 = 15.625 Volume of small shape = 2500 ÷ 15.625 = 160 cm^3

DEFINITIONS – CIRCLE THEOREMS			
107	**Cyclic quadrilateral**	A quadrilateral with all four vertices on the circumference of a circle	
108	A chord is a line that cuts across a circle		
109	The perpendicular from the centre of a circle to a chord bisects the chord.		
110	The line drawn from the centre of a circle to the midpoint of a chord is at right angles to the chord		
111	The triangle formed by two radii and a chord is isosceles		
CIRCLE THEOREMS			
112	**Angles at the centre**	The angles at the centre is twice the angle at the circumference	
113	**Angles in the same segment**	Angles at the circumference in the same segment are equal	
114	**Angle in a semicircle**	Angles in a semicircle are 90°	
115	**Cyclic quadrilaterals**	Opposite angles of a cyclic quadrilateral add to 180° $A + C = 180°$ $B + D = 180°$	
116	**Tangents to a circle**	The angle between a tangent and radius is 90°	
117		Two tangents from the same point to a circle are equal lengths	
118	**Alternate segment**	Alternate segment	

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DEFINITIONS - TRANSFORMATIONS					
119	**Transformation**	Altering a 2D shape in some way. There are four types:			
		Reflection	Rotation	Translation	Enlargement
120	**Rotation**	a "turning" movement of an image about a fixed point			
121	**Reflection**	a "flipping" movement across a mirror line			
122	**Translation**	a "sliding" movement of an image			
123	**Enlargement**	a change in the size of the object (bigger or smaller)			
124	**Scale factor**	The proportions by which the dimensions of an object will increase/decrease by			
125	**Line of reflection**	a "mirror line" which is used to perform reflections			
126	**Centre of rotation**	the fixed point used to rotate an object around			
127	**Centre of enlargement**	a fixed point to enlarge an object from.			
128	**Column Vector**	used to represent translations			$\begin{pmatrix} x \\ y \end{pmatrix}$
129		x is the horizontal movement			
130		x is the vertical movement			
131	**Resultant Vector**	The vector that moves a shape to its final position after a number of translations			
132	**Single Transformation**	Transform the image once			
133	**Combination**	Transform the image multiple times			
134	**Similarity**	images of the same shape, but in different sizes			
135	**Congruent**	Same shape, same size			
136	**Direction**	Clockwise or anti-clockwise			
137	**Co-ordinate**	Points on a graph (x, y)			
138	**Origin**	The point $(0, 0)$, where the x and y axis cross			
140	**2D Shape**	One which has a length/height and a width, but no depth			
141	**Object**	The shape given before a transformation occurs.			
142	**Image**	The shape produced after the transformation			
143	**Symmetry**	One side of a shape exactly mirrors the other			
144	**Rotational Symmetry**	When a shape it is turned around its centre point, it matches its original outline at least once or more			

TRANSFORMATIONS			
145	**Rotation**	A "turning" movement of an image about a fixed point	
146		To describe, you need to write:	a) "Rotation" b) Angle of rotation c) Centre of rotation d) Direction of rotation
147	**Reflection**	A "flipping" movement across a mirror line	
148		To describe, you need to write:	a) "Reflection" b) The equation of the line of reflection
149	**Translation**	A "sliding" movement of an image	
150		To describe, you need to write:	a) "Translation" b) The column vector
151	**Enlargement**	A change in the size of the object (bigger or smaller)	
152		To describe, you need to write:	a) "Enlargement" b) The scale Factor c) The centre of enlargement
153	**Fractional Scale Factor**	If a scale factor is smaller than 1, then the image will be smaller	
154	**Negative Scale Factor**	If a scale factor is negative then the image will be on the opposite side of the centre of enlargement	

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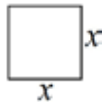
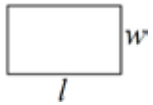
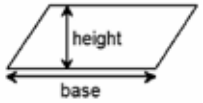
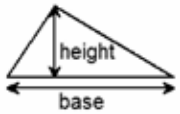
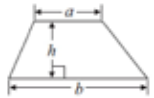
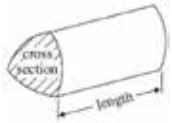
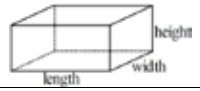
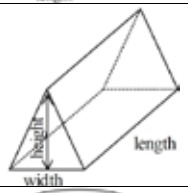
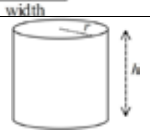
GCSE Mathematics
Geometry 2 – Mensuration and Calculation

DEFINITIONS			
1	**Perimeter**	The distance around the outside of a 2D shape	
2	**Area**	The space inside a 2D shape	
3	**Surface Area**	The total area of all of the faces of a 3D shape	
4	**Volume**	The space inside a 3D shape	
5	**Pyramid**	A 3D shape with a polygon as a base and triangular sides that meet at the top	
6	**Sphere**	A 3D shape where all the points on the surface are the same distance from the centre	
7	**Spherical**	Means in the shape of a sphere	
8	**Prism**	A 3D shape with a constant cross-section	
9	**Isosceles Trapezium**	Has one line of symmetry	
10		The two non-parallel sides are equal length	
11	**Trapezia**	The plural of trapezium	
12	**Capacity**	The amount of fluid a 3D object can hold	
13	**Hectare**	An area of 10 000 m^2	
2D SHAPES			
14	**Square**	$Area = length^2$	
15		$Perimeter = 4 \times length$	
16	**Rectangle**	$Area = length \times width$	
17		$Perimeter = 2 \times (length + width)$	
18	**Parallelogram**	$Area = base \times height$	
19	**Triangle**	$Area = \frac{1}{2} \times base \times height$	

20	**Trapezium**	$Area = \frac{1}{2}(a + b) \times h$	
21	**Compound Shape**	A shape made up of two or more simple shapes	
22		To find the area, split it into the simple shapes, find their areas and then add them together	
23	**Circumference of a circle**	$C = \pi d$	
24	**Area of a circle**	$A = \pi r^2$	
25	**Arc length**	$\frac{x}{360} \times 2\pi r$	
26	**Area of a sector**	$\frac{x}{360} \times \pi r^2$	
27	**Perimeter of a sector**	$\left(\frac{x}{360} \times 2\pi r\right) + 2r$	Arc length + 2 radii
3D SOLIDS			
28	**Surface area**	The total area of all the faces of an object	
29		You can use the shape's net to help calculate the surface area	
30	**Prism**	A 3D shape that has a constant cross-section through its length.	
31		$Volume = area\ of\ cross\ section \times length$	
32	**Cuboid**	$Volume = area\ of\ cross\ section \times length$ $Volume = length \times width \times height$	
33	**Triangular Prism**	$Volume = area\ of\ cross\ section \times length$ $Volume = \frac{1}{2} \times base \times height \times length$	
34	**Cylinder**	$Volume = area\ of\ cross\ section \times length$ $Volume = \pi r^2 h$	
35		$Total\ Surface\ Area = 2\pi r^2 + 2\pi rh$	

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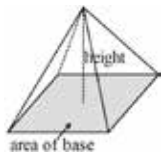
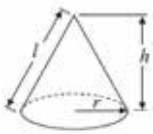
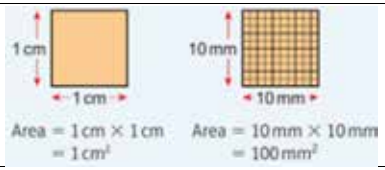
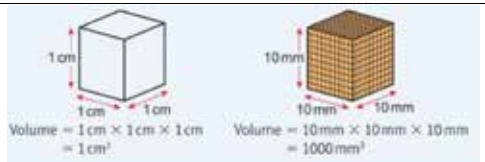
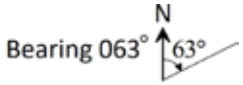
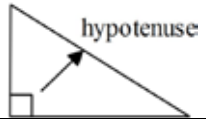
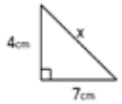
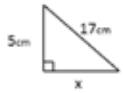
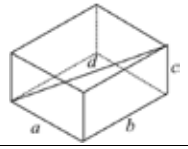
36	**Volume of a Pyramid**	A 3D shape with a polygon as a base and triangular sides that meet at the top	
		$Volume = \frac{1}{3} \times area\ of\ base\ \times height$	
37	**Cone**	$Volume = \frac{1}{3}\pi r^2 h$	
38		$Curved\ Surface\ Area = \pi r l$	
39		$Curved\ Surface\ Area = \pi r^2 + \pi r l$	
40	**Sphere**	$Volume = \frac{4}{3}\pi r^3$	
41		$Surface\ Area = 4\pi r^2$	
UNITS			
42	**Area units**	1 cm^2 = 100 mm^2	
43		1m^2 = 10000 cm^2	
44			
45	**Volume units**	1 cm^3 = 1000 mm^3	
46		1 m^3 = 1000000 cm^3	
47			
48	**Capacity**	Is measured in *ml* and *litres*	
49		1cm^3 = 1*ml*	
50		1000cm^3 = 1 *litre*	

BEARING			
51	**Bearing**	Is the direction of a line in relation to the North-South line	
52		Angle measured clockwise	
53		Measured from north	
54		Always written using 3 digits	
PYTHAGORAS' THEOREM			
55	**Hypotenuse**	The longest side of a right angled triangle. It is opposite the right angle	
56	**Right-angled triangle**	A triangle that contains a right-angle.	
57	**Pythagoras' Theorem**	$a^2 + b^2 = c^2$	
58	**To find the hypotenuse**	 $x^2 = 4^2 + 7^2$ $x^2 = 16 + 49$ $x^2 = 65$ $x = \sqrt{65} = 8.06$ cm	
59	**To find a short side**	 $17^2 = x^2 + 5^2$ $289 = x^2 + 25$ $289 - 25 = x^2$ $x^2 = 264$ $x = \sqrt{264} = 16.25$cm	
3D PYTHAGORAS			
60	**3D Pythagoras' Theorem**	$a^2 + b^2 + c^2 = d^2$ $d^2 - b^2 - c^2 = a^2$	

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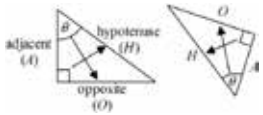
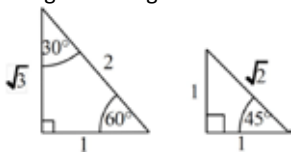
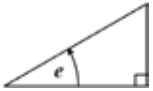
MATHS KNOWLEDGE ORGANISER

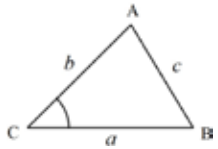
TRIGONOMETRY - SOHCAHTOA – RIGHT ANGLED				
61	**Trigonometry**	The ratios between the sides and angles of triangles		
62	**Labelling the triangle**	H = hypotenuse O = Opposite A = Adjacent θ is the angle involved		
63	**Sine**	$\sin\theta = \frac{O}{H}$	$\theta = \sin^{-1}\frac{O}{H}$	
64	**Cosine**	$\cos\theta = \frac{A}{H}$	$\theta = \cos^{-1}\frac{A}{H}$	
65	**Tangent**	$\tan\theta = \frac{O}{A}$	$\theta = \tan^{-1}\frac{O}{A}$	
66	**Exact values**			

Θ	0°	30°	45°	60°	90°
Sin Θ	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
Cos Θ	1	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0
Tan Θ	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	

These can be found using the triangles:



67	**Angle of elevation**		Angle of depression	

TRIGONOMETRY – NON RIGHT ANGLED			
68	**Area of a triangle**	Area = $\frac{1}{2}ab\sin C$ You can use this formula if you know two sides and the angle between them	
69	**Sine Rule – calculating a side**	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ You use this rule if you know one angle and the opposite side, and one angle and you want to work out the length of its opposite side	
70	**Sine Rule – calculating an angle**	$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$ You use this rule if you know one angle and the opposite side, and one side and you want to work out the size of its opposite angle	
71	**Cosine Rule – calculating a side**	$a^2 = b^2 + c^2 - 2bcCosA$ You use this rule if you know two sides and the included angle and want to work out the missing side	
72	**Cosine Rule – calculating an angle**	$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$ You use this rule if you know all three sides and want to work out an angle	

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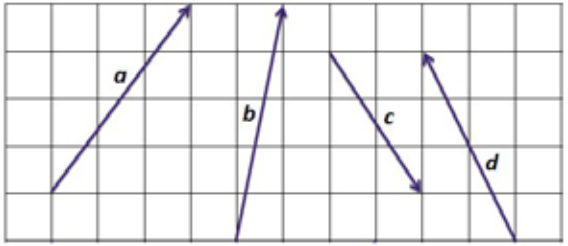
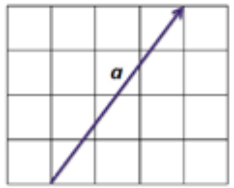
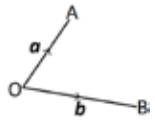
GCSE Mathematics
Geometry 3 – Vectors

DEFINITIONS				
1	**Magnitude**	Size		
2	**Scalar**	A quantity that has a magnitude		
3	**Vector**	A quantity that has a magnitude and a direction		
4	**Column vector**	x is the horizontal movement x is the vertical movement		$\begin{pmatrix} x \\ y \end{pmatrix}$
5	**Written vectors**	Vectors can be written in bold $\boldsymbol{a}$ or with underlining $\underline{\boldsymbol{a}}$		
6	**Vector between two points**	A vector between any two given points, say point L and M, can be written as $\overrightarrow{LM}$		
7	**Vector diagrams**	Vectors can be represented on grids  $\boldsymbol{a} = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$ $\boldsymbol{b} = \begin{pmatrix} 1 \\ 5 \end{pmatrix}$ $\boldsymbol{c} = \begin{pmatrix} 2 \\ -3 \end{pmatrix}$ $\boldsymbol{d} = \begin{pmatrix} -2 \\ 4 \end{pmatrix}$		
8	**Adding vectors**	$\begin{pmatrix} 3 \\ 4 \end{pmatrix} + \begin{pmatrix} 1 \\ 5 \end{pmatrix} = \begin{pmatrix} 4 \\ 9 \end{pmatrix}$		
9	**Subtracting vectors**	$\begin{pmatrix} 3 \\ 4 \end{pmatrix} - \begin{pmatrix} 1 \\ -2 \end{pmatrix} = \begin{pmatrix} 2 \\ 6 \end{pmatrix}$		
10	**Multiply a vector by a scalar quantity**	$3 \times \begin{pmatrix} 2 \\ 5 \end{pmatrix} = \begin{pmatrix} 6 \\ 15 \end{pmatrix}$		

11	**Magnitude of a vector $\lvert\boldsymbol{a}\rvert$**	The magnitude of a vector is the length of the vector The magnitude can be found using Pythagoras' Theorem  $\boldsymbol{a} = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$ $\lvert\boldsymbol{a}\rvert = \sqrt{3^2 + 4^2} = 5 units$
12	**Unit vector**	A unit vector has a magnitude of 1
13	**Combining vectors**	 To travel from Point A to Point B. $\overrightarrow{AB} = \boldsymbol{b} - \boldsymbol{a}$

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MATHS KNOWLEDGE ORGANISER

GCSE Mathematics
Probability

DEFINITIONS			
1	**Probability**	The extent to which an event is likely to occur	
2		It can be given as a fraction, a decimal, or a percentage	
3		It must take a value between zero and 1	
4	**Certain**	An event will definitely happen	e.g. The probability that the day after Sunday is a Monday is 1.
5		Probability of a certain event is 1	
6	**Impossible**	An event will definitely not happen	e.g. The probability that you will have your 3rd birthday tomorrow is 0
7		probability of an impossible event is 0	
8	**Biased**	Unfair	
9	**Unbiased**	Fair	
10	**Mutually Exclusive**	When events cannot happen at the same time	e.g. Rolling an even number and rolling a 5 on one dice
11	**Exhaustive**	Events are exhaustive if they cover all possible outcomes	
12	**Dependent**	When the outcome of one event changes the probability of the next event, the two events are not independent	
13	**Independent**	Two events are independent if the results of one do not affect the results of the other	
14	**Not Independent**	When the outcome of one event changes the probability of the next event, the two events are not independent	
15	**Sample space**	Shows all of the possible outcomes for one or more events	
16		Could be shown as a list, or a 2-way table, or a tree diagram	
17	**P( ) Notation**	P() means the probability of the thing inside the brackets happening	e.g. P(Tails) is the probability of getting a tails
18	**AND Rule**	If two events are independent, multiply the probabilities	P(A AND B) = P(A) × P(B)
19	**OR Rule**	If two events are mutually exclusive, Add the probabilities	P(A OR B) = P(A) + P(B)
20	**Conditional probability**	The probability of a dependent event. The probability of a second outcome depends on what has already happened in the first outcome	

THEORETICAL PROBABILITY			
21	**Theoretical Probability**	Calculated without doing an experiment	
22	**Calculating probabilities**	For equally likely outcomes the probability that an event will happen is $P = \frac{number\ of\ successful\ outcomes}{total\ number\ of\ possible\ outcomes}$	
23		e.g. The probability of rolling a 6 on a dice is $\frac{1}{6}$	
24		The probabilities of all possible outcomes add up to 1.	
25	If the probability that something WILL happen is **p** The probability that it WILL NOT happen is **1 - p**		e.g. Probability it will rain = 0.3 Probability it will not rain = 1 - 0.3 = 0.7
26	P(A) + P(NOT A) = 1	If the probability that something WILL happen is $\boldsymbol{p}$	The probability that it WILL NOT happen is $\mathbf{1} - \boldsymbol{p}$
27		They are mutually exclusive	e.g. P(rain) = 0.3 P(not rain) = 1 - 0.3 = 0.7
EXPERIMENTAL PROBABILITY			
28	**Estimated probability**	also known as experimental probability	
		$estimated\ probability = \frac{frequency\ of\ event}{total\ frequency}$	
29	**Relative frequency**	In an experiment, how often something happens as a proportion of the number of trials	
30		Can be used to estimate probabilities	
31		Relative frequency = $\frac{how\ often\ something\ happens}{all\ outcomes}$	
32	Your estimated probability gets more accurate the more trials you do		
33	**Predictions**	You can predict the number of outcomes you will get by: Predicted number of outcomes = probability x number of trials	

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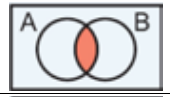
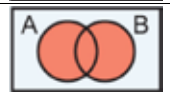
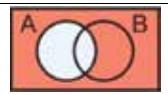
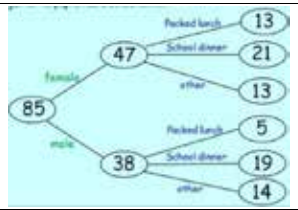
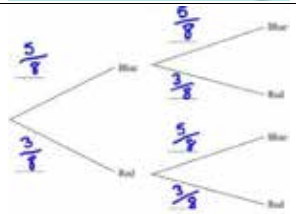
VENN DIAGRAMS				
34	$\{\}$	Curly brackets show a set of values	$5 \in \{\text{odd numbers}\}$ means "5 is in the set of odd numbers"	
35	$\in$	Means "is an element of"		
36	**Element**	A "member" of a set		
37	ξ	Means the universal set	All the elements are being considered	
38	**A ∩ B**	A intersection B	All elements in A AND B	
39	**A ∪ B**	A union B	All the elements in A OR B OR both	
40	**A '**	Not A	All the elements NOT in A	
41	$P(A \cap B \mid B)$	The probability of A And B given B		
TREE DIAGRAMS				
42	**Frequency Tree**	Shows the number of different options for different choice		
43	**Probability Tree**	Shows all possible outcomes of an event		
44	**AND Rule**	Multiply the probabilities	P(A and B) = P(A) x P(B)	
45	**OR Rule**	Add the probabilities	P(A or B) = P(A) + P(B)	

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GCSE Mathematics
Statistics

DEFINITIONS					
1	**Qualitative**	Data described by words			
2	**Quantitative**	Data that is categorized by numbers, it can be discrete or continuous			
3	**Discrete data**	Can be counted, can only have a finite number of possible values			
4	**Continuous data**	Can be measured, can have an infinite number of possible values within a selected range			
5	**Inequality signs**	< less than	> greater than	≤ less than or equal to	≥ greater than or equal to
COLLECTING DATA					
6	**Sample**	A selection from the whole population			
7	**Census**	A survey of the whole population			
8	**Population**	The whole group			
9	**Bias**	Unfair, sways the results inaccurately			
10	**Random Sample**	Every member of the population has an equal chance of being included			
11	**Strata**	The name given to groups that a population has been divided into e.g. year groups in a school, gender, age			
12	**Stratified sample**	A sample where the number of people chosen from each strata is in proportion to the strata size			
13	**Capture-recapture**	A sampling method used to estimate the size of the population of an animal species			
MEASURES OF CENTRAL TENDENCY AND SPREAD					
14	**Mean**	Add up all of the amounts. Divide by how many values there are			
15	**Median**	Put values in order. Locate the middle value			
16	**Mode**	The value that occurs most often			
17	**Range**	The biggest value minus the smallest value			
18	**Outlier**	An extreme data value that doesn't fit the overall pattern			

ADVANTAGES & DISADVANTAGES OF AVERAGES

19

Average	Advantages	Disadvantages
Mean	**Every value makes a difference**	**Affected by extreme values**
Median	**Not affected by extreme values**	**May not change if a data value changes**
Mode	**Easy to find; not affected by extreme values; can be used with non-numerical data**	**There may not be a mode**

AVERAGES FROM FREQUENCY TABLES

20 **Modal Class** — The class with the highest frequency

21 **Median** — If the total frequency is *n*, then the median lies in the class with the $\frac{n+1}{2}$th value in it.

22 **Mean from a frequency table**

Times →
Add ↓↓
Divide ←

Data value	Frequency	Frequency x Data Value
2	3	6
3	2	6
4	5	20
	10	32

Mean $= 32 \div 10 = 3.2$

23 **Estimated mean from a grouped frequency table**

Times →
Add ↓↓
Divide ←

Data value	Frequency	Midpoint	Frequency x Data Value
$20 \leq x < 30$	3	25	75
$30 \leq x < 40$	2	35	70
$40 \leq x < 50$	5	45	225
	10		370

Mean $= 370 \div 10 = 37$
There is a loss of accuracy due to using the midpoint, this is why it is only an estimate.

24 **Estimate of range** — The maximum possible value subtract the minimum possible value

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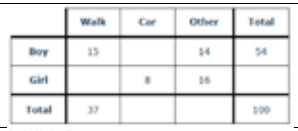
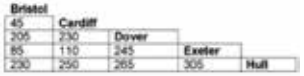
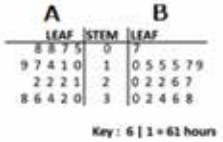
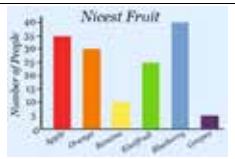
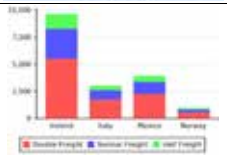
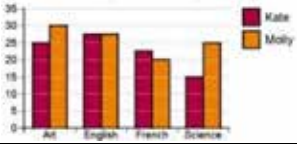
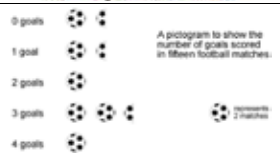
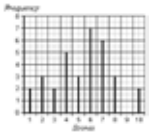
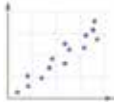
DATA DISPLAYS			
25	**Two Way Tables**	Tables used to compare the relationship between two discrete data categories.	
26	**Distance Chart**	A convenient way of showing the distances between several places	
27	**Stem and leaf**	A data display that shows groups of data arranged by place value. Leaves should be in order. Must have a key.	
28	**Back-to-back stem and leaf**	Compares 2 sets of results Must always have a key	
29	**Bar Chart**	A graphical display of data where the bar heights show the frequencies	
30	**Composite Bar Chart**	The bars identify are split to show different quantities within each bar	
31	**Dual bar chart**	A bar chart to compare data sets by drawing adjoining bars for each.	
32	**Pictogram**	A chart using pictures to represent quantities. Must have a key to say what each picture represents.	
33	**Time Series Graph**	A line graph with time plotted on the horizontal axis	

34	**Vertical Line Diagram**	A graphical display of data where the line heights show the frequencies	
35	**Pie Chart**	A circular chart where the pie sectors are used to show the relative sizes of data	
36	**Frequency Polygon**	A graph made by plotting the frequency against midpoints of grouped data	
SCATTER DIAGRAMS			
37	**Scatter diagram**	A graphical diagram with points plotted to show a relationship between two variables	
38	**Bivariate data**	Data of two variables we want to compare to look for relationships	
39	**Positive Correlation**	As one variable increases, the other variable increases	
40	**Negative Correlation**	As one variable increases, the other variable decreases	
41	**No Correlation**	As one variable increases, the other variable shows no connection	
42	**Line of best fit**	A line of best fit is drawn on a scatter diagram so that it is as close as possible to the points	
43	**Interpolation**	Using a line of best fit to predict values within the range of data given. Usually accurate	
44	**Extrapolation**	Using a line of best fit to predict values outside the range of data given. May not be accurate	
45	**Outlier**	A value far away from the rest of the data	

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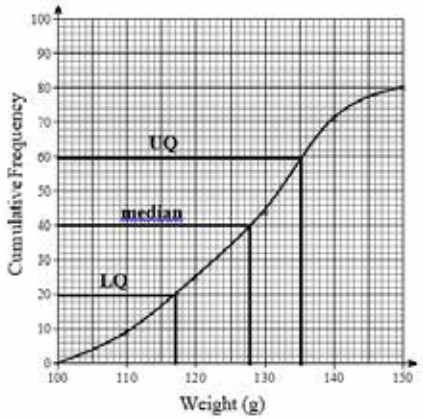
REPRESENTING DATA			
46	**Cumulative frequency**	A running total of frequencies	
47	**Cumulative frequency table**	A table that shows how many data items are less than or equal to the upper class boundary of each data class	
48	**Upper class boundary**	The highest possible value in each class	
49	**Cumulative frequency diagram**	A graph with the data values on the x-axis and cumulative frequency on the y-axis	
50	**Quartiles**	The 3 values that divide a set of ranked data into 4 equal groups, each group comprising a quarter of the data.	
51	**Median**	The middle quartile and has 50% of the data below its value	
52	**Lower quartile**	The first quartile and has 25% of the data below its value	
53	**Upper quartile**	The third quartile and has 75% of the data below its value	
54	**Interquartile range (IQR)**	IQR = Upper quartile – lower quartile	
55	**Box plot**	A diagram that displays the median, quartiles, minimum and maximum values for a set of data	
56	**Histogram**	A chart where the area of each bar represents the frequency	
57	**Frequency density**	The height of each bar in a histogram	$Frequency\ Density = \frac{Frequency}{Class\ width}$

58 **Cumulative Frequency Diagram**

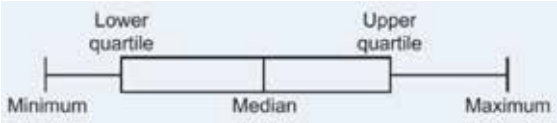
Weight (w grams)	Frequency	Cumulative Frequency
$100 \le w < 110$	9	9
$110 \le w < 120$	16	25
$120 \le w < 130$	19	44
$130 \le w < 140$	27	71
$140 \le w < 150$	9	80

Median = **128** Lower Quartile = **117**

Upper Quartile = **135** IQR = **135 – 117 = 18**



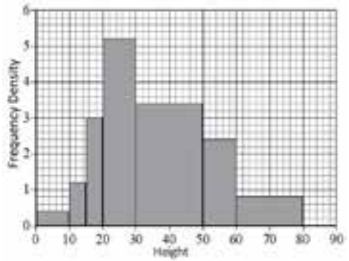
59 **Box Plot**



60 **Histogram**

$$Frequency\ Density = \frac{Frequency}{Class\ Width}$$

Height (h cm)	Frequency	Class Width	Frequency density
0 ≤ h < 10	4	10	4 ÷ 10 = 0.4
10 ≤ h < 15	6	5	6 ÷ 5 = 1.2
15 ≤ h < 20	15	5	15 ÷ 5 = 3
20 ≤ h < 30	52	10	52 ÷ 10 = 5.2
30 ≤ h < 50	68	20	68 ÷ 20 = 3.4
50 ≤ h < 60	24	10	24 ÷ 10 = 2.4
60 ≤ h < 80	16	20	16 ÷ 20 = 0.8



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