PiXL Gateway: Progression – Maths

Year 12-13 Maths

Contents:

I. Maths Vocabulary

MATHS:

Currently, within the Maths section of the app, we have the following unit:

- Core 1
- Core 2
- Mechanics
- Statistics

Core 1 Keywords and Definitions

Word	Definition
arithmetic sequence	An arithmetic sequence is a sequence of terms that increase or decrease by a common difference.
base	The number raised using an index in a power is the base.
chain rule	The chain rule is used to differentiate a composite function.
completing the square	Completing the square is the process in which a quadratic expression is written as the sum of a new expression that is squared, and a constant.
cubic	An expression (or equation) of degree 3, with a term in x^3 and one or more of terms in x^2, x and a constant, is a cubic.
curve	A line that is not straight for some, or all, of its length is a curve.
definite integral	The area between the curve generated by plotting a function, one of the co-ordinate axes and the two straight lines given by the limits of the integral is a definite integral.
degree	The degree of a polynomial is the highest index to appear in a polynomial.
denominator	The denominator is the number or expression on the bottom of a fraction.
derivative	The derivative is the gradient function associated with a function.
differentiate	To differentiate is the process by which the derivative, or gradient function, of a function is obtained.
discriminant	The discriminant is the value of $b^2 - 4ac$ for a quadratic expression.
domain	The domain is the set of numbers for which a function is defined.
exact form	A number is in exact form if it has not been subject to any rounding.
expand	The process of multiplying two or more algebraic expression to give a single, usually more complex, expression is to expand.
exponential	An exponential expression is one in which the variable appears in the index.
factor theorem	The factor theorem says that if $x - a$ is a factor of $f(x) = 0$, then $x = a$ is a solution of $f(x) = 0$.
factorise	The process of expressing a number or algebraic expression as a multiple of smaller numbers or simpler terms is to factorise.

function	A function is an operation that associates each element of a domain with one element of a range. Although more than one element in the domain can be mapped to an element in the range, a function cannot map an element in the domain to more than one element in the range.
geometric sequence	A geometric sequence is a sequence of terms that change multiplicatively, using a common ratio.
identity	A relationship that is true for all values of x is called an identity.
indefinite integral	The indefinite integral is the set of functions whose derivatives will equal the function being integrated.
index	The index is the number to which a base is raised in a power.
indices	Indices is the plural form of the word 'index'.
inequality	An inequality is an expression, which superficially looks like an equation, in which one side is greater than the other.
integer	A whole number that does not have a fractional part is an integer.
integration	The process by which an integral of a function is obtained. Integration is the process of finding the area under a curve.
intersection	A point at which two lines meet. In set theory, the intersection of two sets is the set of elements that are members of both sets.
irrational number	An irrational number is any number that cannot be expressed as a fraction, whose numerator and denominator are both integers.
linear	An expression (or equation) of degree 1, with a term in x and a constant (which may be 0), is linear.
logarithm	The logarithm of a number, x, to a base, a, is the power to which a must be raised to obtain x.
manipulation	Manipulation is the process of combining algebraic expressions, usually by addition, subtraction, multiplication or division.
natural number	An integer greater than 0 is a natural number.
normal	A normal to a curve at a point on the curve is a straight line which is perpendicular to the curve at that point.
numerator	The numerator is the number or expression on the top of a fraction.
parallel	Two or more lines whose directions are the same are parallel.
perpendicular	A line is perpendicular to another line, a curve at a point, or a surface, if it is at right angles to it.
polynomial	A polynomial is the sum of two or more multiples of powers of x.
power	In mathematics, the power is a base raised using an index.
product rule	The product rule is used to differentiate a function obtained by multiplying two functions.
quadratic	An expression (or equation) of degree 2, with a term in x^2 and one or both of a term in x and a constant, is a quadratic.
quotient rule	The rule used to differentiate a function obtained by dividing two functions is the quotient rule.

range	The set of numbers that results from using a function to map a domain is the range.
rational number	Any number that can be expressed as a fraction whose numerator and denominator are both integers is a rational number.
rationalise the denominator	If we rationalise the denominator, we are carrying out the process in which the numerator and denominator of a fraction are manipulated so that its denominator is a rational number.
real numbers	Real numbers are the set obtained by uniting the sets of rational numbers and irrational numbers.
reciprocal	The reciprocal of a number is the result of dividing a number into 1.
second derivative	The derivative of the derivative is the second derivative.
sequence	A sequence is a set of terms linked by a rule or pattern.
series	A series is a sum of a sequence of terms.
simultaneous equation	A set of two or more equations, each containing two or more variables whose values can simultaneously satisfy both or all the equations, is a set of simultaneous equations.
stationary point	A stationary point is one at which the derivative of a function is zero.
surds	Surds are irrational square roots which are expressed in exact form, where the integer inside the square root is kept as small as possible.
tangent	A tangent is a straight line which just touches a curve at a point.

Core 2 Keywords and Definitions

Word	Definition
asymptote	A line approached, but never reached, by a curve, usually as the value of x or y approaches infinity is an asymptote.
binomial expansion	A binomial expansion is the result of expanding an expression of the form (a + b) raised to the power n.
cartesian	Cartesian co-ordinates use x and y values to identify a point on a plane (in two dimensions) or x, y and z values to identify a point in space (in three dimensions).
combined function	A combined function is the result of adding, subtracting, multiplying or dividing two or more functions.
composite function	The composite of two functions is the result of substituting one function into the other. For example, the composite function gf(x) = g(f(x)) is the result of substituting f(x) into the function g.
proof by contradiction	In mathematics, proof by contradiction can be used to disprove a statement by showing that the statement leads to a false result.
convergent	A sequence is convergent if it approaches one particular value (a limit).
counter example	A counter example can be used to disprove a statement by obtaining a single value for which that statement is not true.
proof by deduction	Proof by deduction is the commonest type of proof, and is a step by step method for reaching a conclusion based on established principles.

difference	In mathematics, the difference between two numbers can be found by subtracting the smaller number from the larger number.
differential equation	A differential equation is one that includes a derivative, dy/dx, for which the solution will be an equation connecting the values of x and y, and not including dy/dx.
divergent	In mathematics, a sequence is divergent if it doesn't approach any particular value (a limit). Such a sequence may become infinite, or it may alternate between two or more values.
proof by exhaustion	In mathematics, proof by exhaustion means considering a statement for each of a finite number of cases and proving each case separately.
infinity	Infinity is a number greater than any assignable quantity or countable number.
inverse	The inverse of a function is a second function that returns each output value to its original input value.
iteration	Iteration, in mathematics, is repetition of a mathematical process applied to a previous result to obtain successively closer approximations to the solution of an equation.
limit	A limit, in mathematics, is a value approached by a convergent sequence. In definite integration, the two limits are the values between which the integral is calculated.
mapping	A mapping, in mathematics, is an operation that associates each element of a given set with one or more elements of a second set.
modulus	Modulus is the size of a number, having no regard to whether it is positive or negative.
Newton-Raphson method	The Newton-Raphson method is an iterative method that, if successful, quickly converges to a root of an equation of the form f(x) = 0.
parametric equation	A parametric equation uses a third parameter, often denoted t, to define the (x , y) values of the points on a curve.
partial fractions	Partial fractions are algebraic fractions expressed as the sum of two or more simpler algebraic fractions whose denominators are linked to the factors of that of the original fraction.
periodic	A periodic function repeats its values in regular intervals or periods.
product	The product of two numbers is the result of multiplying them.
proof	Proof is the process by which the truth of a fact or statement is established.
radians	Radians is a unit of angular measure. One radian is equal to the angle subtended by an arc whose length is equal to the radius of the circle.
recurrence	A recurrence relation defines a sequence using a rule that gives the next term as a function of the previous term (or terms). It is sometimes known as a term-to-term rule.
roots	Roots are values that satisfy an equation.
sector	A sector, in mathematics, is part of a circle formed by enclosing two radii and an arc.
segment	A segment is part of a circle formed by enclosing a chord and an arc.
sigma	Sigma, which is usually represented symbolically using the upper case Greek letter Σ, is used to indicate the sum of a series.
sketch graph	A sketch graph, while not plotted accurately, gives the shape and key features of a graph.
sum	The sum of two numbers is the result of adding them.

trapezium rule	The trapezium rule is a method for finding the approximate area under a curve using trapezia.

Mechanics Keywords and Definitions

Word	Definition
acceleration	Acceleration is the rate at which the velocity of a particle is changing with respect to time.
at rest	In mathematics, an object is at rest when its velocity is zero.
bead	A bead is a particle that can slide along a wire or rod.
constant	The word constant describes a quantity that does not change.
contact force	A contact force is one resulting from the contact between an object and a surface, or two objects.
deceleration	Deceleration is acceleration that has the effect of slowing down the speed of a particle.
displacement	Displacement is the distance from, and direction to, a particle from a fixed point, or the distance and direction between two particles.
distance	Distance, in mechanics, is how far a particle is from a fixed point or another particle.
equilibrium	Equilibrium is the state of a particle that is at rest and on which the total of the forces being exerted is zero.
force	A force is a push or pull upon an object.
friction	Friction is a force resisting motion due to the contact between two rough surfaces.
gravity	Gravity is the force that attracts a body towards the centre of the Earth, or towards any other physical body having mass.
inextensible	A string is inextensible if its length does not change when a tension is exerted on the string.
lamina	A lamina is an object with an area whose thickness, compared to other distances, is negligible and can be taken to be zero. It is usually taken to have a mass greater than zero.
light	The word light describes an object (usually a string or a rod) whose mass is so small in comparison to other objects that it can be taken to be zero.
magnitude	Magnitude is the size of a quantity.
mass	Mass is a measure of the amount of matter in an object. The mass of an object remains constant, irrespective of its location.
maxima	Maxima is the plural form of the word maximum.
minima	Minima is the plural form of the word minimum.
minimum	The minimum is the lowest possible value of a quantity. A curve may have a “local” minimum if it has a turning point but then takes a lower value in another part of the curve.
moment	The moment of a force about a point is the product of the size of the force and the perpendicular distance from the point to the line of action of the force.

negligible	Negligible refers to a quantity that is so small in comparison to other quantities that it can be taken to be zero.
Newtons	The SI unit of force is the Newton.
particle	A particle is an object with a mass but whose size, compared to other distances, is negligible and can be taken to be zero.
plane	A plane, in mechanics, is a flat surface, which may be smooth or rough.
projectile	A projectile, in mechanics, is a particle moving freely under gravity, and not under the action of any other forces.
pulley	A pulley is a wheel around which a string passes, which acts to change the direction of a force applied to the string.
reaction	In mechanics, a reaction is a force exerted between two objects. The direction of the reaction between a surface and an object is perpendicular to the surface.
resistance	Resistance is a force acting against the direction of motion (or intended direction of motion) of a particle.
resultant	The resultant force (or simply “resultant”) is the total of the forces acing on an object.
rod	A rod is a straight length of wire whose thickness, compared to other distances, is negligible and can be taken to be zero.
rough	A surface is rough if there is friction between the surface and any object placed upon it.
scalar	A scalar is a quantity with magnitude but not direction.
smooth	A surface is smooth if there is no friction between the surface and any object placed upon it.
speed	The speed is the rate at which an object is travelling.
tension	Tension is a pulling force in a string connecting two particles that tends to pull those particles together.
thrust	Thrust is a pushing force in a rod connecting two particles that tends to push those particles apart.
uniform	If a property of an object remains constant at every part of the object, that property is said to be uniform.
vector	A vector is a quantity with magnitude and direction.
velocity	Velocity is the rate at which the displacement of a particle is changing with respect to time. It comprises the speed of the particle and its direction of motion.
weight	On the surface of the Earth, the weight of an object is the force equal to the product of its mass and the gravitational constant g.
wire	A wire is a rigid piece of string whose shape does not change under the action of a force, and whose thickness, compared to other distances, is negligible and can be taken to be zero.

Statistics Keywords and Definitions

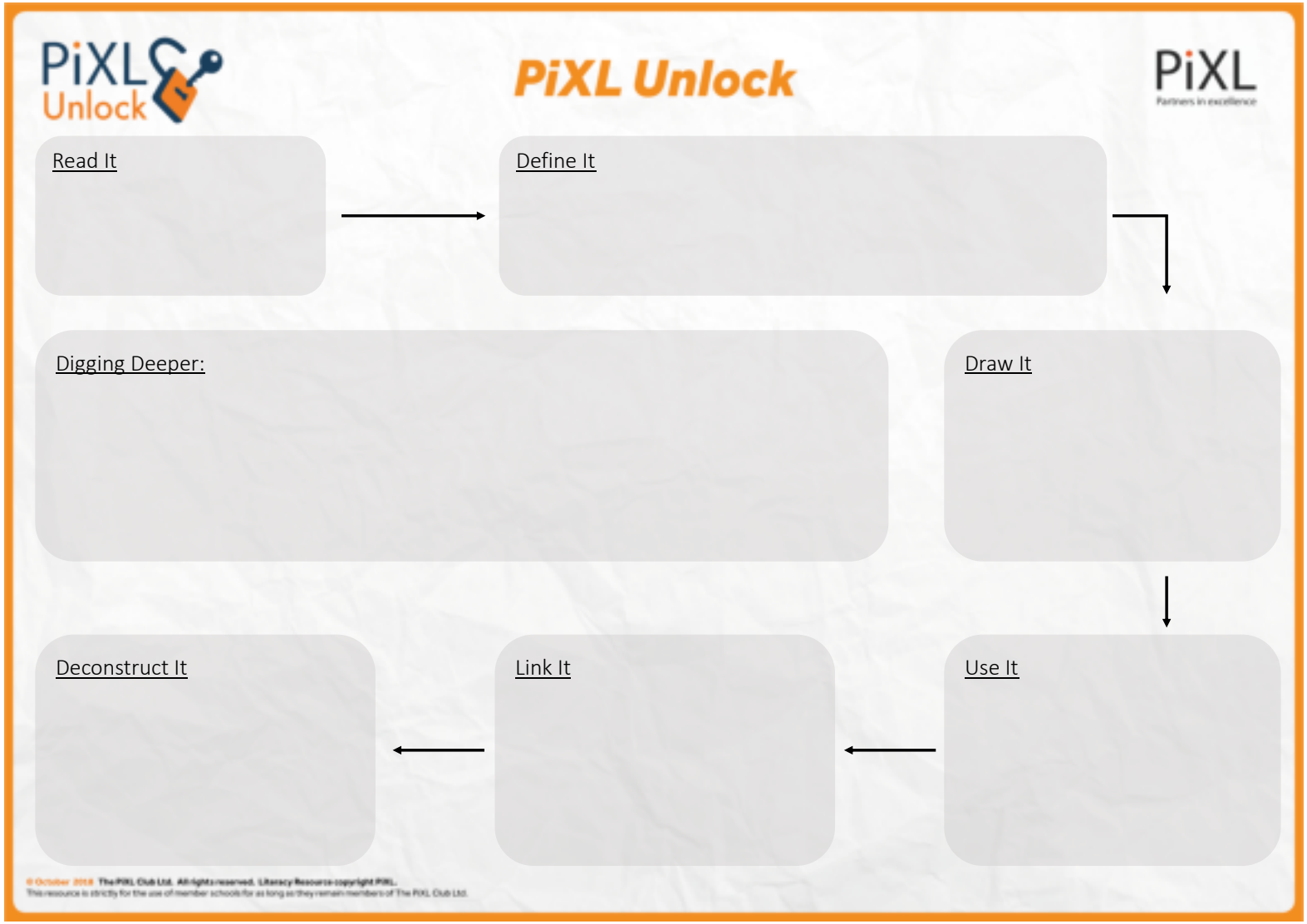
Word	Definition
acceptance region	The acceptance region is a set of outcomes of a statistical test for which the null hypothesis is to be accepted.

alternative hypothesis	The alternative hypothesis is the hypothesis that sample observations are influenced by some non-random cause.
binomial distribution	Binomial distribution is a probability distribution associated with repetitions of an experiment for which there are exactly two possible outcomes.
bivariate data	Bivriate data is data about each of two variables, where each value of one is paired with a value of the other.
causality	Causality in relationship between two events implies that one event is affected by the other.
census	A collection of data from the whole population is a census.
conditional probability	The probability that an event occurs given that another event has already occurred is the conditional probability.
continuous data	Continuous data is not restricted to defined separate values, but can occupy any value over a continuous range.
correlation	Correlation quantifies the degree to which two variables are related.
critical region	The critical region is the set of outcomes of a statistical test for which the null hypothesis is to be rejected.
critical value	The critical value is the value above or below which the null hypothesis is to be rejected. The term is also used in the solution of inequalities.
data	The word data refers to facts, numbers or information from which conclusions may be drawn.
dependent variable	Where two variables are connected, the dependent variable will change in response to changes in the independent variable.
discrete data	If data is said to be discrete, it can only take particular values. There may be an infinite number of those values.
event	An event is a subset of all the possible outcomes of an experiment.
experiment	An experiment is a procedure that can be infinitely repeated and has a set of possible outcomes.
explanatory variable	An explanatory variable is one which is not dependent on another.
frequency density	For grouped data, the frequency density is obtained by dividing the frequency by the width of each interval.
histogram	A histogram is a means of displaying continuous data (in a form that superficially resembles a bar chart), plotting frequency density against the values of the data.
hypothesis	A statistical hypothesis is an assumption or statement about a population that is to be tested.
independent events	Independent events are two events for which the outcome of one event has no influence on the outcome of the other.
independent variable	An independent variable is one which is not dependent on another.
linear interpolation	Linear interpolation is a method by which an estimate of a percentile can be obtained for grouped data.
median	Once a set of quantitative data is ordered, the median is the value in the middle.
mode	Mode is the most commonly occurring value in a set of data.

mutually exclusive events	Mutually exclusive means two possible events which cannot happen simultaneously.
normal distribution	Normal distribution is a continuous distribution with a symmetrical bell-shaped probability density curve, defined by its mean and standard deviation.
null hypothesis	The null hypothesis is the hypothesis that sample observations result purely from chance.
one-tailed	A one-tailed test is a test of a hypothesis where the region of rejection is on only one side of the distribution.
outcome	An outcome is a result of an experiment or trial.
percentile	A percentile is the value below which a given percentage of a set of data falls.
population	A statistical population is a group of existing objects or individuals, from which a sample may be taken and data obtained.
primary data	Primary data is original data that has been collected especially.
probability distribution	A probability distribution links each outcome of an experiment with the probability that it occurs.
qualitative data	Qualitative data is descriptive information.
quantitative data	Quantitative data can be measured and is normally numerical.
quartile	A quartile of a set of data will be found at each of the 25th, 50th and 75th percentiles.
quota sampling	In quota sampling, members of a population are first segmented into mutually exclusive sub-groups, just as in stratified sampling. Then members are chosen from each segment based on a specified proportion.
random sample	A random sample is a process of selection in which every member of the population has an equal probability of being chosen for a sample.
random variable	A random variable is a variable that can take different values, each with an associated probability.
range	The range is the minimum value in a set of data, subtracted from the maximum value.
region	A region is an area within which we make a judgement about a statistic.
regression	Regression analysis predicts a value of a dependent variable based on a known value of an independent variable.
response variable	Where two variables are connected, the response variable will change in response to changes in the independent (or explanatory) variable.
sampling	Sampling is a means of collecting data from part of a population.
scatter diagram	A scatter diagram is a diagram which represents the bivariate data associated with members of a sample or population by using co-ordinates.
significance level	For a hypothesis test, significance level is the degree of certainty that is required for the acceptance of a hypothesis.
standard deviation	Standard deviation is the square root of the variance, a measure of spread.
stratified sample	A stratified sample is a process of selection in which the sample is chosen to reflect the proportion of members in the population with given characteristics.

systematic sampling	Systematic sampling of a population starts by randomly selecting a member from a list of members of the population, then selecting further members at a fixed interval through the list.
tree diagram	A tree diagram is used to represent the outcomes of two or more experiments with discrete outcomes.
two-tailed	A two-tailed test is a test of a hypothesis where the region of rejection is on both sides of the distribution, and is usually symmetrical.
variance	Variance is a measure of spread that uses every value in a set of data.
Venn diagram	A Venn diagram uses circles to show relationships between sets of data.

II. The PiXL Unlock Template



III. Summer Reading list

- Fermat's Last Theorem (Singh)
- Does God Play Dice and Nature's Numbers (Stewart)
- Easy as Pi (Ivanov)
- The Music of the Primes (du Sautoy)
- Just Six Numbers (Rees)
- In Code (Flannery)
- Numbers, Sets and Axioms (Hamilton)
- The Universe and the Teacup – the Maths of Truth and Beauty (K.C. Cole)
- Algebra and Geometry (Beardon)
- Hidden Connections, Double Meanings (Wells)
- Elastic Fishponds. The Maths that Governs our World (Elwes)
- The Norm Chronicles (Blastland and Spitgethaltes), Our Mathematical Universe (Max Tegmark)
- Updates for 2018 are Beyond Infinity (Cheng)
- Weapons of Math Destruction (O'Neill)
- Ian Stewart's 17 equations that Changed the World and Thinking in Numbers (Temmet)

IV. Links to TED Talks/Articles/Documentaries/Books/Journals

www.ted.com/talks/hannah_fry_is_life_really_that_complex

www.ted.com/talks/hannah_fry_the_mathematics_of_love

(associated book) The Mathematics of Love (Fry)

www.ted.com/talks/arthur_benjamin_the_magic_of_fibonacci_numbers

www.ted.com/talks/marcus_du_sautoy_symmetry_reality_s_riddle

(search BBC iPlayer for) Marcus du Sautoy 'A Brief History of Mathematics'

www.alexbellos.com

www.theguardian.com/science/alexs-adventures-in-numberland

(look especially for 'tube map for A level maths aims to drive smart thinking')

www.chalkdustmagazine.com ("a magazine for the mathematically curious")

www.mrbartonmaths.com/students/a-level

www.mathsgenie.co.uk/alevel

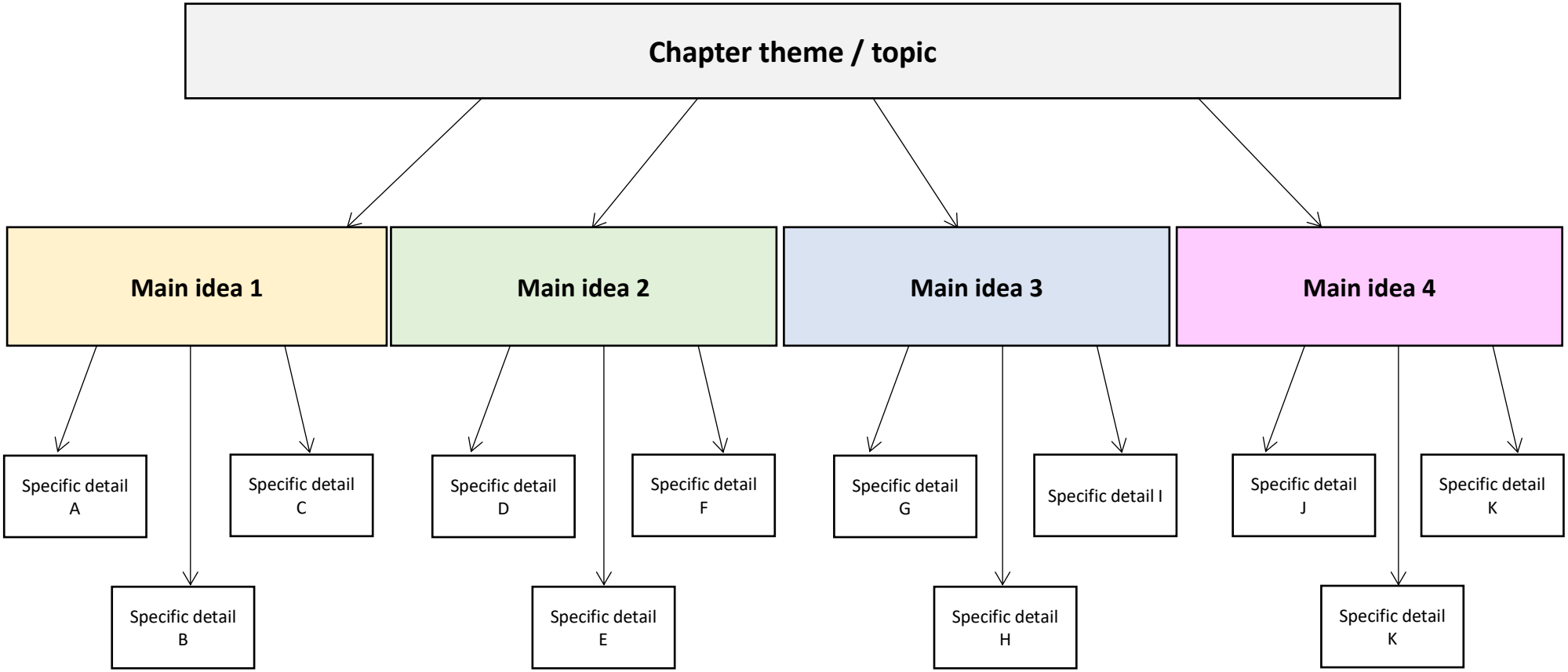
www.ukmt.org.uk/individual-competitions/senior-challenge/archive

(the senior challenge is suitable for A and AS level students)

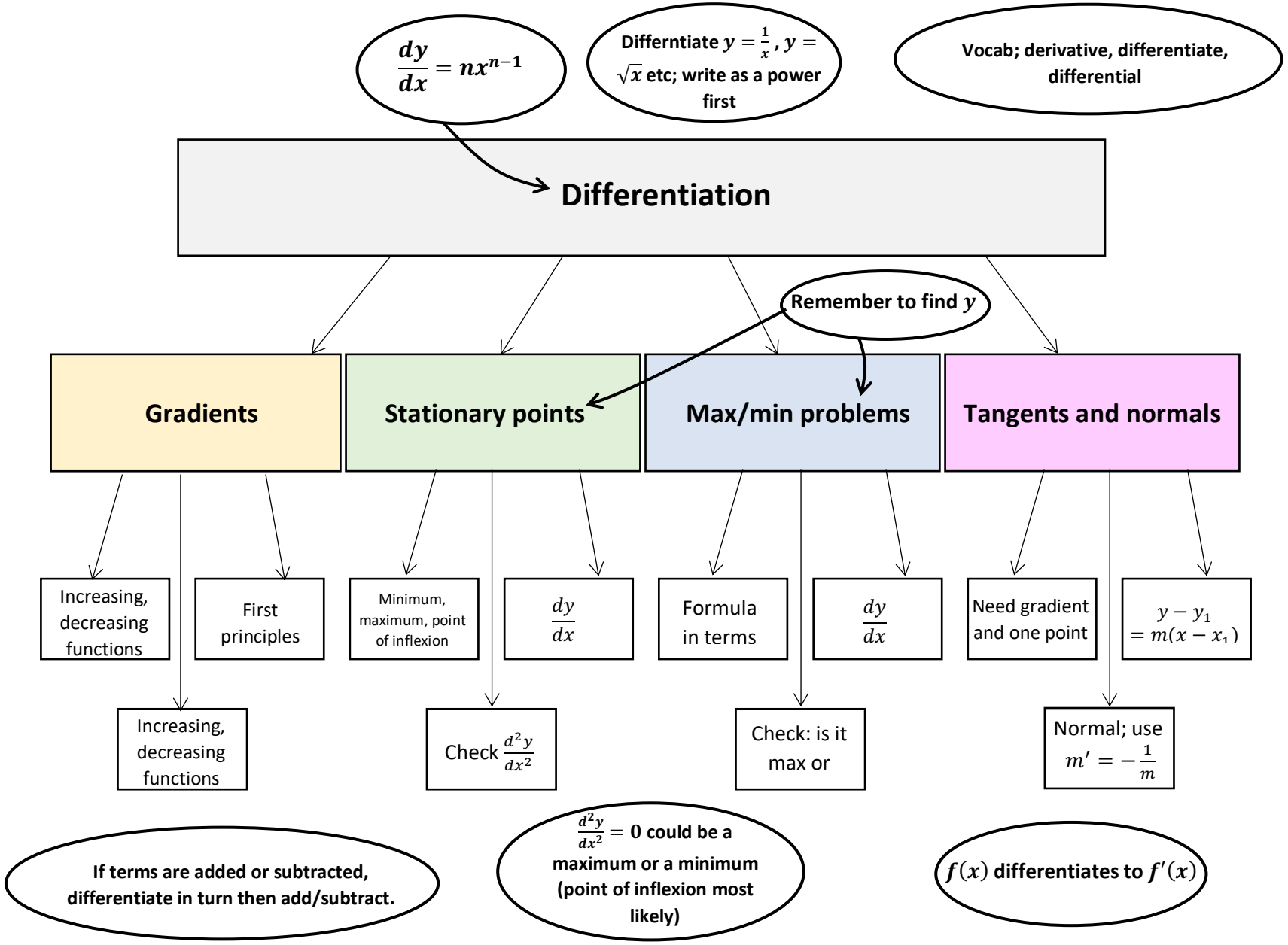
http://furthermaths.org.uk/a-level-problem-solving

V. Knowledge Organiser Template

VI. Thinking Hard Revisit Template



VII. A Model of the Thinking Hard Revisit document



VIII. Cornell Notes Template

Name	Date
Topic	Subject

Main Ideas	Notes

Summary

IX. A Model of the Cornell Notes document

Name	Date
Topic Forces	Subject Mechanics

Main Ideas	Notes
Unit	Newton (derived SI unit; 1 N is equivalent to 1 kg m s^{-2}).
Force as a vector	Forces can be added together; their resultant is the single force that has the same effect as the individual forces combined. Triangle of forces (etc). Newton's First Law: If the resultant of the forces acting on an object is 0, it will move with constant velocity. Body in equilibrium; resultant of forces acting on the body is 0 and velocity is 0. In a straight line, use positive and negative according to the direction of the force. Keep to same orientation as velocity, acceleration, etc. In two dimensions, resolve forces into two components (for example "horizontal and vertical"). Use Pythagoras (to find magnitude of two perpendicular forces) and trigonometry (to resolve into components, etc).
F = ma	Value of F is the resultant of the forces on a body. See Newton's Second Law. Vector form **F** = m**a**
Weight	Not the same as mass. Weight is a force equal to the mass multiplied by g, the acceleration due to gravity (generally given as 9.8 ms^{-2}). W = mg Always acts vertically downwards. If a body is at rest on a horizontal surface, there must be a force (usually a normal reaction) acting vertically upwards.

Summary

F = ma

Resolve forces into components, add forces to find resultant.

Constant velocity - resultant force equals 0.