Long Term Curriculum Map

Subject and Year: Year Y13 Mathematics | Specification (KS4/5 only): | VOCABULARY

Dates taught / curriculum time	PRIOR KNOWLEDGE What should they already know / when was this last visited	CORE KNOWLEDGE What will they know at the end of this topic: Learn that…	CORE KNOWLEDGE: Learn how to…	MISCONCEPTIONS/ THRESHOLD CONCEPTS	AMBITION FOR ALL QUESTIONS	FORMAL ASSESSMENT
Term 1- Teacher A Chapter 4 Sequences and Series Textbook 2 p63-92	Be able to find the formula for the nth term of a linear sequence. **Example: Find the nth term of 2, 5, 8, 11** Use term-to-term rules to generate sequences. **Find the next term of the sequence U1 = 4 Un+1 = 3Un -2** Solve quadratic equations and inequalities **Find values of x that satisfy $3x^2 + 7x > 163$** Solve exponential equations and inequalities **Find the smallest n that satisfies $3.5x1.2^n > 75$** Solve linear simultaneous equations. **Example: solve a+4b=8 3a+5b=3** Use modulus notation **Example: List all integers r that satisfy $\left\|\frac{3r}{5}\right\| < 2$**	An increasing sequence is one where each term is larger than the previous one: $U_{n+1} > U_n$ for all n. A decreasing function is one where each term is smaller than the previous one: $U_{n+1} < U_n$ for all n. A periodic sequence is one where the terms start repeating after a while. $U_{n+k} = U_n$ for some k (the period of the sequence) A convergent sequence is one where the terms approach a limit as n increases, and a divergent sequence is one where they increase/decreased without a limit. Sigma notation is a shorthand way to describe a series $\sum_{r=1}^{r=n} u_r = u_1 + u_2 + \cdots + u_n$ Here the Greek capital sigma, means add up the terms from the 1st to the nth. Arithmetic sequences have a common difference, denoted by d and a first term denoted by a. The nth term of an arithmetic sequence is given by: $u_n = a + (n-1)d$ The sum of the first n terms of an arithmetic sequence is given by $S_n = \frac{n}{2}[2a + (n-1)d]$ or $S_n = \frac{n}{2}(a + L)$ where L is the last term. A geometric sequence has a common ratio, denoted by r. The nth term of a geometric sequence $U_n = ar^{n-1}$ The sum of the first n terms of a geometric series is given by: $S_n = \frac{a(1-r^n)}{1-r}$	Determine the behaviour of a sequence, specifically to determine if it is a convergent or divergent sequence. To use sigma notation for series. Find the sum of n terms of a sequences. Analyse and calculate terms for an arithmetic sequence with a common difference. Find the sum of n terms of a arithmetic sequence. Analyse and calculate terms for a geometric sequence with a common ratio between terms. Find the sum of n terms of a geometric sequence. Calculate the sum to infinity of a geometric sequence and explain the conditions for this to happen. Apply sequences to real-life problems, including ones with log functions.	Mistaking a sequence and a series. Forgetting that a series is a sum of terms. Thinking that a divergent sequence has a value of the asymptote and not that it tends to the asymptote. Errors when using sigma notation- particularly when the summation doesn't start at r=0 or r=1 Mixing up the formula for geometric and arithmetic series. Forgetting that an arithmetic sequence has a common difference and a geometric sequence has a common ratio.	What is the difference between a sequence and a series? What is the difference between a decreasing and an increasing sequence? Can you give examples of both? Explain the difference between a divergent and convergent sequence. Can you give examples for each one? Explain how to use sigma notation. What is an arithmetic sequence? What do the values of a, d and l represent in the formulae? What is a geometric sequence? Give an example of an increasing and decreasing geometric sequence. What do the variables r, a and l stand for in the geometric series formulae? What is the period of a sequence? Can you give an example of a sequence which has a period of 4?	

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		An n increases the sum of a geometric series converges to $S_\infty = \frac{a}{1-r}$ if $\|r\| < 1$ This is called a sum to infinity of the series. If $\|r\| > 1$ then the series diverges.				
Term 1- Teacher B Further Differentiation Textbook 2 p1967-218	Be able to differentiate the functions x^n, sin x, cos x, e^x and ln(x) Use differentiation to find the equations of tangents and normal and stationary points. Know the basic trigonometric identities. Know the definitions of the reciprocal trigonometric functions. Simplify expressions involving fractions and surds. Change the formula of a subject	The chain rule is defined: If $y = f(u)$, where $u = g(x)$, then $$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$$ Specific examples of the chain rule, lead to the following results: 1) $\frac{d}{dx} f(ax+b) = af'(ax+b)$ 2) $\frac{d}{dx}(e^{kx}) = ke^{kx}$ 3) $\frac{d}{dx}(\ln kx) = \frac{k}{\|kx\|} = \frac{1}{\|x\|}$ 4) $\frac{d}{dx}(\sin kx) = k \cos kx$ 5) $\frac{d}{dx}(\cos kx) = -k \sin kx$ 6) $\frac{d}{dx}(\tan kx) = k\, sec^2\, kx$ We can use the method of substitution and reciprocal trig functions to derive the results: 1) $y = \sec x$ $\frac{dy}{dx} = \sec x \tan x$ 2) $y = cosec\ x$ $\frac{dy}{dx} = -cosec\ x \cot x$ 3) $y = \cot x$ $\frac{dy}{dx} = -cosec^2 x$ The quotient rule is defined: If $y = \frac{u}{v}$ then $\frac{dy}{dx} = \frac{vu' - uv\prime}{v^2}$ Explicit equations are ones in the form $y = f(x)$ whereas implicit equations are in the form $f(x) = f(y)$ When differentiating implicitly, you need to use: $\frac{d}{dx}[f(y)] = f'(y) \times \frac{dy}{dx}$ Using substitution and implicit differentiation leads to the result: $\frac{d}{dx}(a^x) = a^x \ln a$ The derivative of the inverse function is $$\frac{dy}{dx} = \frac{1}{\frac{dy}{dx}}$$	Differentiate composite functions using the chain rule. Specifically functions in the form $y = (ax+b)^n$, $y = e^{f(x)}$ And $y = \sin(f(x))$ Differentiate products and quotients of function including with examples involving polynomials, trig functions, exponential and log functions. Recognise implicit functions and how to differentiate them. Including examples that incorporate the product rule. Differentiate inverse functions. Apply all the new differentiation rules to find gradients at specific points, normal and tangents, stationary points and the second derivative to verify the nature of stationary points.			

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Term 1– Teacher A Functions 2 Textbook 2- p10—39	Interpret function notation **Eg Given that $f(x) = 2 - x$, evaluate $f(-4)$** Use set notation and interval notation Able to complete the square including examples where the coefficient of ax^2 a>1 Solve quadratic inequalities Rearrange exponential and log expressions. Establish where a function is increasing or decreasing.	A mapping is a function if every input value maps to a single output value. This can be checked by using the vertical line test. A function is one-to-one if every y value corresponds to only one x value. This can be checked by using the horizontal line test. A function is many-to-one if there is at least one y value that comes from more than one x value. The set of allowed input values is called the domain of the function. The set if all possible outputs of a function is called the range. A composite function is where one function is applied to another function. This can be defined: If we have functions, $f(x),\ \ g(x)$ then the composite function is $f\left(g(x)\right) = fg(x) = f°g(x)$ The composite function $ff(x)$ can also be written as $f^2(x)$ If we have the function, $y = f(x)$ then the inverse function is given by $y^{-1} = f^{-1}(x)$. The inverse function is a reflection in the line $y = x$ and only $1-1$ functions have inverses. To calculate this, we use the following steps: 1) Start with $y = f(x)$ 2) Rearrange to get x (the input) in terms of y (the output) 3) Give $f^{-1}(x)$ by replacing every instance of y with x. The domain of $f^{-1}(x)$ is the same as the range of $f(x)$. The range of $f^{-1}(x)$ is the same as the domain of $f(x)$.	To explain the difference between mappings and functions and determine if we have a 1-1, 1-many, many-1 or many-many mapping. Calculate the domain and range of a function, including using correct set notation to do this. Sketch functions when given a particular domain and calculate the range. To find composite functions algebraically and use this to find specific values. Extend to find composite functions of multiple functions. To find the inverse of a function, explain the conditions for this to be possible and how to restrict the domain of a function to enable an inverse to be found. Draw an inverse function by reflecting the original function in the line y=x including examples involving trig functions.		•	

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Term 2 Teacher B Further Integration Techniques Textbook 2 Chapter 11 p219 – 245	Be able to differentiate and integrate polynomial, exponential and trigonometric functions. Use the chain rule for differentiation Use the double angle formulae	We can use the "inverse chain rule" to derive the results: 1) $\int f(ax+b)dx = \frac{1}{a}F(ax+b)+c$ Where $F(x)$ is the integral of $f(x)$ 2) $\int e^{kx}dx = \frac{1}{k}e^{kx}+c$ 3) $\int \sin(kx)dx = \frac{-1}{k}\cos(kx)+c$ 4) $\int \cos(kx)dx = \frac{1}{k}\sin(kx)+c$ When the numerator of a fraction if the derivative of the denominator, we get the following result: $\int \frac{f'(x)}{f(x)}dx = \ln\lvert f(x)\rvert + c$ For the method of integration by substitution, we apply the following procedure: 1) Select a substitution (usually $u = ..$) 2) Differentiate the substitution and write dx in terms of du. 3) Replace dx by the expression above and replace any obvious occurrences of u 4) Change the limits from x to u 5) Simplify as far as possible 6) If any terms of x remain, write them in terms of u 7) Do the new integral in terms of u 8) Write the answer in terms of x When we have a function in the form $y = f(x)g(x)$ then we can use the formula for integration by parts: $\int u\frac{dv}{dx}dx$= uv - $\int v\frac{du}{dx}dx$ To integrate trigonometric functions with powers of two or greater, we use identities to help. Specifically: 1) To integrate sin^2x we use $\cos(2x) = 1 - 2sin^2x$ 2) To integrate cos^2x we use $\cos(2x) = 2cos^2x - 1$	Use the inverse chain rule to integrate functions which include in polynomial form, exponential functions and trigonometric functions. Identify when an integration needs a substitution, apply the chain rule to change the function in terms of a new variable, change limits accordingly and then integrate. To recognise integrals where the process of integration by parts is needed. Apply the process to integrals including examples with exponential and rational expressions. Recognise integrals where integration by parts is needed to be used twice. Use integration by parts in order to find the integral of $y = ln\,(x)$ Apply identities to trigonometric expressions in order to get them in a form which we can integrate.			

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Term 2 Teacher A Partial Fractions Chapter 5 p93-106	Add algebraic fractions Carry out polynomial division Use the factor theorem	If $f\left(\frac{b}{a}\right) = 0, then\ (ax - b)$ is a factor of $f(x)$ We can use polynomial division to divide rational functions. Specifically: If $P(x)$ is a polynomial then $\frac{P(x)}{ax+b} = Q(x) + \frac{r}{ax+b}$. Here Q($x$) is called the quotient and r is the remainder. We can decompose a rational function into separate fractions- this is called partial fractions. Specifically: 1) $\frac{mx+n}{(x+p)(x+q)} = \frac{A}{x+p} + \frac{B}{x+q}$ 2) $\frac{mx+n}{(x+p)(x+q)(x+r)} = \frac{A}{x+p} + \frac{B}{x+q} + \frac{C}{x+r}$ 3) $\frac{mx+n}{(x+p)(x+q)^2} = \frac{A}{x+p} + \frac{B}{x+q} + \frac{C}{(x+q)^2}$ Some rational functions can be integrated by splitting into partial fractions first.	Use the factor theorem and polynomial division to factorise polynomials completely. Express rational functions into partial fractions, including examples with a repeated root. Use laws for logs, integration results and inverse chain rule to integrate rational functions- including definite results.			
Term 1 Teacher A Further Transformations of Graphs	Recognise a graph transformation from the equation. Change the equation of a graph to achieve a given transformation Use interval notation to express solution of inequalities.	When two vertical transformations or two horizontal transformations are combined, changing the order may affect the outcome. When one vertical and one horizontal transformation are combined, the outcome does not depend on the order. The modulus or the absolute value is a function that converts any negative values to positive values. Specifically: $$\lvert x\rvert = \begin{cases} x & x \geq 0 \\ -x & x < 0 \end{cases}$$ To sketch the graph of $y = \lvert f(x)\rvert$, start with the graph $y = f(x)$ and reflect any parts below the x-ais	Apply multiple transformation to a function and draw the resultant graph. This includes reflections, translations and stretches. Calculate the absolute value of a number. Draw the absolute value of graphs including ones which have additional transformations eg $y = \lvert x - 3\rvert + 4$			
Term 2 Teacher A General Binomial Expansions Textbook 2 Chapter 6 127-137	Simplify expressions with exponents Use binomial expansions for positive integer powers Write expressions in partial fractions	That we can use binomial expansion for any polynomial with negative and fractional power. The general form is given by: If $\lvert x\rvert < 1$ then $(1 + x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \ldots$	Expand $(a + bx)^n$ where n is any rational power. Including specifically where n is negative or fractional. Calculate specific coefficients in an expansion, including examples where two expansions need to be multiplied or represented as a fraction.			

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	Write inequalities using the modulus function	The binomial expansion of $(a+bx)^n = a^n\left(1+\frac{bx}{a}\right)^n$ is valid for $\left\|\frac{bx}{a}\right\| < 1$ We can use the first few terms of a binomial expansion to approximate the expression for small values of x. A rational function may need to be written in partial fractions before using the binomial expansion.	Pull out a factor of a^n to transform $(a+bx)^n$ into a form we can use the basic result. Describes when a binomial expansion will converge by applying the vilification formula. Use partial fractions to write expressions in the form required for the binomial expansion Use binomial expansions to approximate functions.			
Term 2 Teacher A Numerical Solution of Equations ChTextbook 2 – chapter 14 p297-329	Rearrange equations involving polynomials, fractions, exponentials, logarithms, and trigonometric functions Differentiate a variety of functions Use term-to-term rule to generate sequence.	If $f(x)$ is a sufficiently behaved function and a and b are numbers such that $f(x)$ changes sign between a and b, then the equations $f(x) = 0$ has at least one root (solution) between a and b. This is called the change of sign method. A lack of change of sign does not necessarily imply there are no roots and the change of sign rule can fail. For example if the graph of $f(x)$ has a vertical asymptote, a break, or touches the x-axis. The Newton-Raphson method is defined as: Given an approximate root x_n of the equation $f(x) = 0$, a better approximation is: $$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$ The Newton-Raphson method doesn't work if the starting value is a stationary point or if the root is close to the stationary point. The sequence may initially (or permanently) ,move away from the root. The process of fixed-point iteration involves solving an equation in the form $x = g(x)$. 1) Using a starting guess x_1, generate a sequence x_{n+1}=$g(x_n)$ 2) If this sequence converges to a limit, then this limit is a solution to the equation. The limitations of fixed-point iteration are:	Some equations cannot be solved by algebraic rearrangements. Find an interval that contains a root of an equation, and how to check that a given solution is correct to a specific degree of accuracy (the change of sign method) Approximate a part of the curve by a tangent and use this to find an improved estimate for a solution (Newton-Raphson method) Create a sequence that converges to a root of an equation (fixed-point iteration) Identify situations in which the methods fail to find a solution.			

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		1) Some rearrangements of the equation leads to convergent sequences and others to divergent sequences 2) A divergent sequence does not find the required root 3) Is an equation has more than one root, different rearrangements may converge to different roots. A fixed point x_{n+1}=$g(x_n)$: a) Converges if $\lvert g'(x)\rvert < 1$ near the root and x_1 is sufficiently close to the root b) Diverges is $\lvert g'(x)\rvert > 1$ near the root.				
Term 2 Teacher A Numerical Integration Textbook 2 Chapter 15 P33-354	Calculate the area of a trapezium Know that a definite integral represents the area between the curve and an axis How to find distance from a velocity-time graph	You can find the upper and lower bounds for the area under a curve by using rectangles that lie above and below the curve. The actual area lies between the lower and the upper bound. As the number of rectangles increases, the upper and lower bounds approach a limit, which is the actual value of a definite integral The trapezium rule can be used to estimate the area under a curve. It is defined by: $\int_b^a f(x)dx \approx \frac{h}{2}[y_0 + y_n + 2(y_1 + y_2 + \cdots + y_{n-1)})]$ Where $y_1 = f(x_1)$ and $h = \frac{b-a}{n}$ To determine whether the trapezium rule gives an underestimate or overestimate, you need to look at the shape of the graph.	Definite integration is connected to the area under a curve. To approximate integrals that can't be found exactly by using the trapezium rule. Explain how we can increase the accuracy of our answer by increasing the number of strips used in the trapezium rule. Establish whether these approximations are overestimates or underestimates.			
Term 1 Teacher B Further Applications of Calculus Textbook 2 Chapter 12 P310-345	Find the first and second derivatives of various functions, including by using the chain, product, and quotient rules. Use trigonometric identities to simplify expressions and solve equations	A curve that curves upwards is called convex and has $\frac{d^2y}{dx^2} > 0$ A curve that curves downwards is called concave and has $\frac{d^2y}{dx^2} < 0$ At a point of inflection, $f''(x) = 0$ and the curve changes form convex to concave or concave to convex	To use the second derivative to determine the shape of a curve Describe complex curves by using an additional parameter. Use the chain rule to differentiate parametrically, fins stationary points, tangents and normals. How to find the area between two curves, or between a curve and the y-axis.			

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	Use integration to find areas between a curve and an axis. Integrate various functions, use substitution and integration by parts.	A point where both $f'(x)=0$ and $f''(x)=0$ can be any of the three types of stationary point. To determine which one it is, you need to look at the gradient on either side of the point. Parametric equations are a way of describing a curve where both x and y coordinates are given in terms of a parameter (usually called t or ∅). Each parameter value corresponds to a single point on the curve. The gradient of a curve given in parametric form is $\frac{dy}{dx}=\frac{\left(\frac{dy}{dt}\right)}{\left(\frac{dx}{dt}\right)}$ The area between the x-axis and a part of the curve with parametric equations $(x(t), y(t))$ is given by $\int_{t_1}^{t_2} y\frac{dx}{dt}dt$, where t_1 and t_2 are the parameter values at the end points. The chain rule can be used to connect rates of two related variables. If u depends on t, and y depends on u, then $\frac{dy}{dt}=\frac{dy}{du}\times\frac{du}{dt}$. You often need the geometric context of the question to work out how y depends on u. The area enclosed by two curves with equations $y=f(x)$ and $y=g(x)$ is given by $\int_a^b\big(f(x)-g(x)\big)dx$, where a and b are x-coordinates of the intersection points. The area between a curve, the y-axis and the lines $y=c$ and $y=d$ is given by $\int_c^d g(y)dy$, where $x=g(y)$ is the expression for x in terms of y				
Term 2 Teacher B Differential Equations	Integrate using partial fractions and simplify using log rules Use integration by substitution and by parts	A differential equation is an equation for the derivative of a function. To solve a differential equations means to find an expression for the function itself. Some differential equations can be solved by separation of variables. This is where we write	Use basic integration to solve basic differential equations in the form $\frac{dy}{dx}=f(x)$ and use boundary conditions to find particular solutions. Solve differential equations in the form $g(y)\frac{dy}{dx}=f(x)$ by separating variables			

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	Integrate using trigonometric identities Write equations involving related rates of change Rearrange expressions involving exponents and logarithms Draw force diagrams and find net force.	the equation in the form $g(y)\frac{dy}{dx} = f(x)$ and integrate both sides. Initial or boundary conditions can be used to find the constant of integration and therefore find the particular solution of the equation. Differential equations often describe the rate of change of a quantity; this is the derivative with respect to tie. The rate of change is often proportional to one of the variables. You met need to use given information to find the constant of proportionality. Sometimes a problem involves more than one variable and you need to use related rates of change to write a differential equation.	including specifically examples involving exponentials and logarithms.			
Statistics Chapter 16 Conditional Probability	Understand the basic laws of probability including the terms "mutually exclusive" and "independent". Be able to use tree diagrams to solve problems Be able to find simple conditional probabilities Understand and be able to use set notation Understand probability distributions, including the binomial distribution	We can use set notation when describing probabilities: $A \cap B$ is the intersection of A and B, meaning when both A and B happen $A \cup B$ is the union of A and B, meaning when either A happens, or B happens, or both happen A' is the compliment of A, meaning everything that could happen other than A A Venn diagram leads to a formula relating the probabilities of the union and intersection: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ $P(A\|B)$is the probability of A happening if B has happened. This can be visualised using the Venn diagrams, two-way tables or tree-diagrams. We can use the formula: $P(A\|B) = \frac{P(A \cap B)}{P(B)}$ In a tree diagram we often rearrange this formula to get: $P(A \cap B) = P(A)$x $P(B)$ and $P(B)$x $P(A\|B)$= $P(A)$x $P(B\|A)$	Use set notation to describe probabilities Learn how to work with unconditional probabilities in the context of Venn diagrams, two-way tables and tree diagrams. Learn formula for conditional probability			

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Statistics Chapter 17 Normal Distribution	Be able to interpret histograms Be able to work with tree diagrams Be able to calculate conditional probability Be able to use the binomial distribution Be able to solve simultaneous equations	The normal distribution models many physical situations. It is described completely once we know its mean (μ) and its variance (σ^2). Calculators can provide the probabilities of being in any given range. The following values are useful to know: Approximately 99.7% of the data lie within three standard deviations of the mean Approximately 95% of the data will lie within two standard deviations of the mean Approximately two-thirds of the data will lie within one standard deviation of the mean The Z-score is the number of standard deviations above the mean that has a given cumulative probability. It is related to the equation: $z = \frac{x - \mu}{\sigma}$ If we know probabilities relating to a variable with a normal distribution, we can deduce information about the variable using the inverse normal distribution We need to use the Z-score when the mean or the standard deviation are unknown If $X \sim B(n, p)$ with $np > 5$ and $nq > 5$ (where $q = 1 - p$), then X can be approximated by a normal distribution with $\mu = np$ and $\sigma^2 = npq$	Calculate probabilities for a normally distributed random variable That any normal distribution is related to the standard normal distribution Calculate the value of the variable with a given cumulative probability Find the mean and standard deviation from information about probabilities The normal distribution can be used as a model The normal distribution can be used as an approximation to the binomial distribution			
Statistics Chapter 18 Further Hypothesis Testing	Be able to interpret correlation coefficients Be able to conduct hypothesis tests using the binomial distribution	The sample mean, $\bar{X}$, is a random variable If $X \sim N(\mu, \sigma^2)$, then $\bar{X}_n \sim N(\mu, \frac{\sigma^2}{n})$ To test the value of a population mean, μ, against a suggested value, μ_0: Set up appropriate hypotheses, depending on the context. Either $H_0: \mu = \mu_0$ $H_1: \mu \neq \mu_0$	The sample mean is a random variable How the sample mean is distributed How to test whether the mean of a normally distributed population is different from a predicted value			

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	Be able to perform calculations using the normal distribution	Or $H_0: \mu = \mu_0 \;\; H_1: \mu > \mu_0$ Or $H_0: \mu = \mu_0 \;\; H_1: \mu < \mu_0$ Then, use the distribution of $\bar{X}$ and your calculator to either find the p-value or set up the critical region for the given significance level, α If $p \leq \alpha$ (or if $\bar{X}$ is in the critical region), reject H_0 To test whether there is correlation between two variables: Set up appropriate hypotheses, depending on the context. Either $H_0: \rho = 0 \;\; H_1: \rho \neq 0$ Or $H_0: \rho = 0 \;\; H_1: \rho > 0$ Or $H_0: \rho = 0 \;\; H_1: \rho < 0$ Then look up in the tables the critical values for the given significance level and sample size If the modulus of the sample correlation coefficient, r, is greater than the critical value, then reject H_0.	How to test whether a set of bivariate data provides evidence for significant correlation			
Mechanics Chapter 19 Applications of Vectors	Be able to link displacement vectors to coordinates and perform operations with vectors Be able to find the magnitude and direction of a vector Understand the concepts of displacement and distance; instantaneous and average velocity and speed; acceleration	Constant acceleration formulae in two dimensions: $\mathbf{v}=\mathbf{u}+\mathbf{a}t$ $\mathbf{s}=\mathbf{u}t+\frac{1}{2}\mathbf{a}t^2$ $\mathbf{s}=\mathbf{v}t-\frac{1}{2}\mathbf{a}t^2$ $\mathbf{s}=\frac{1}{2}(\mathbf{u}+\mathbf{v})$ To differentiate or integrate a vector, differentiate or integrate each component separately Vectors in three dimensions can be expressed in terms of **base vectors**, $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$ using **components**.	Use displacement, velocity and acceleration vectors to describe motion in two dimensions Use some of the constant acceleration formulae with vectors Use calculus to relate displacement, velocity and acceleration vectors in two dimensions when acceleration varies with time Represent vectors in three dimensions using base vectors, $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$ Use vectors to solve geometrical problems in three dimensions			

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		Learn that…	Learn how to…			
	Be able to use constant acceleration formulae in one dimension Be able to use calculus to work with displacement, velocity and acceleration in one dimension Know how to work with curves defined parametrically	The magnitude of a vector can be calculated using the components of the vector: $\|\mathbf{a}\| = \sqrt{a_1^2 + a_2^2 + a_3^2}$ The distance between the points with position vectors $\boldsymbol{a}$ and $\boldsymbol{b}$ is given by $\|\boldsymbol{b} - \boldsymbol{a}\|$ The unit vector in the same direction as $\boldsymbol{a}$ is $\hat{\mathbf{a}} = \frac{1}{\|\boldsymbol{a}\|} \text{x } \boldsymbol{a}$				
Mechanics Chapter 20 Projectiles	Be able to find the magnitude and direction of a vector Be able to use constant acceleration formulae in one dimension Be able to use constant acceleration formulae in two dimensions Be able to use trigonometric identities to solve trigonometric equations	In projectile motion the acceleration of the particle is $\mathbf{a} = \begin{pmatrix} 0 \\ -g \end{pmatrix} ms^{-2}$ where the y-axis points vertically upwards The modelling assumptions for projectile motion are: The projectile is modelled as a particle Air resistance can be ignored The value of g If a particle is projected with speed u at and angle θ above the horizontal, then the components of the initial velocity are: Horizontally: $u_x = u\cos\theta$ Vertically: $u_x = u\sin\theta$ A projectile is at its maximum height when v_y =0 For a particle projected from ground level, set y =0 to find the range (the maximum horizontal distance travelled) To find an equation for the trajectory of a projectile: Make t the subject of the $x = (u\cos\theta)t - \frac{1}{2}gt^2$	Model projectile motion in two dimensions Find the maximum height and range of a projectile Find the Cartesian equation of the trajectory of a projectile			

Dates taught / curriculum time	PRIOR KNOWLEDGE What should they already know / when was this last visited	CORE KNOWLEDGE What will they know at the end of this topic		MISCONCEPTIONS/ THRESHOLD CONCEPTS	AMBITION FOR ALL QUESTIONS	FORMAL ASSESSMENT
		Learn that…	Learn how to…			
Mechanics Chapter 21 Forces in Context	Be able to add vectors and find magnitudes Be able to find horizontal and vertical components of a vector Be able to solve problems involving motion with constant acceleration	To resolve a force in a given direction, draw a right-angled triangled triangle with the force as the hypotenuse and the other sides of the triangle parallel and perpendicular to the direction of interest When calculating motion on a slope, resolve forces parallel and perpendicular to slope rather than vertically and horizontally. In particular, the components of weight acting on a slope inclined at an angle θ to the horizontal are: Down the plane: $mg\sin\theta$ Perpendicular to the plane: $mg\cos\theta$ The contact force between an object and a surface has two components: The normal contact force, perpendicular to the surface The frictional force, parallel to the surface The maximum or limiting value of friction, $F_{\max}$, between an object and a surface given by $F_{\max} = \mu R$ where R is the normal reaction force between the object and the surface, and μ is the coefficient of friction. If an object is stationary and the sum of all the other forces parallel to the surface, excluding friction, is smaller than $F_{\max}$, the object will remain the at rest and the friction force, F_r will equal the sum of the other forces If the sum of all the forces parallel to the surface excluding friction, is larger than $F_{\max}$, the object will move and $F_{\mathrm{r}} = \mu R$	How to resolve forces in a given direction in order to calculate the resultant force About a model for friction How to determine the acceleration of a particle moving on an inclined plane			
Mechanics Chapter 22 Moments	Be able to recognise types of force acting on a particle Understand when a particle is in equilibrium	The moment of a force F about an axis is: Moment $= Fd$ Where d is the perpendicular distance of the line of action of the force from the axis. In two dimensions, the distance is measured from the point where the axis of rotation passes through the plane of the body. The centre of mass is the point at which the object's weight acts. For a uniform rod, this is at the midpoint For a uniform rectangular lamina, this is at its point of symmetry	How to find the turning effect of a force About uniform rods and laminas How to find the centre of mass of a non-uniform rod About rotational equilibrium			

Dates taught / curriculum time	PRIOR KNOWLEDGE What should they already know / when was this last visited	CORE KNOWLEDGE What will they know at the end of this topic		MISCONCEPTIONS/ THRESHOLD CONCEPTS	AMBITION FOR ALL QUESTIONS	FORMAL ASSESSMENT
		Learn that…	Learn how to…			
		For a non-uniform rod, you can find its position by considering moments To find the resultant moment about a point, find the sum of the clockwise and anticlockwise moments separately. The resultant moment will be the difference between the two sums (in the direction of the larger). If an object is in equilibrium, there is zero resultant force and zero resultant moment about any point				