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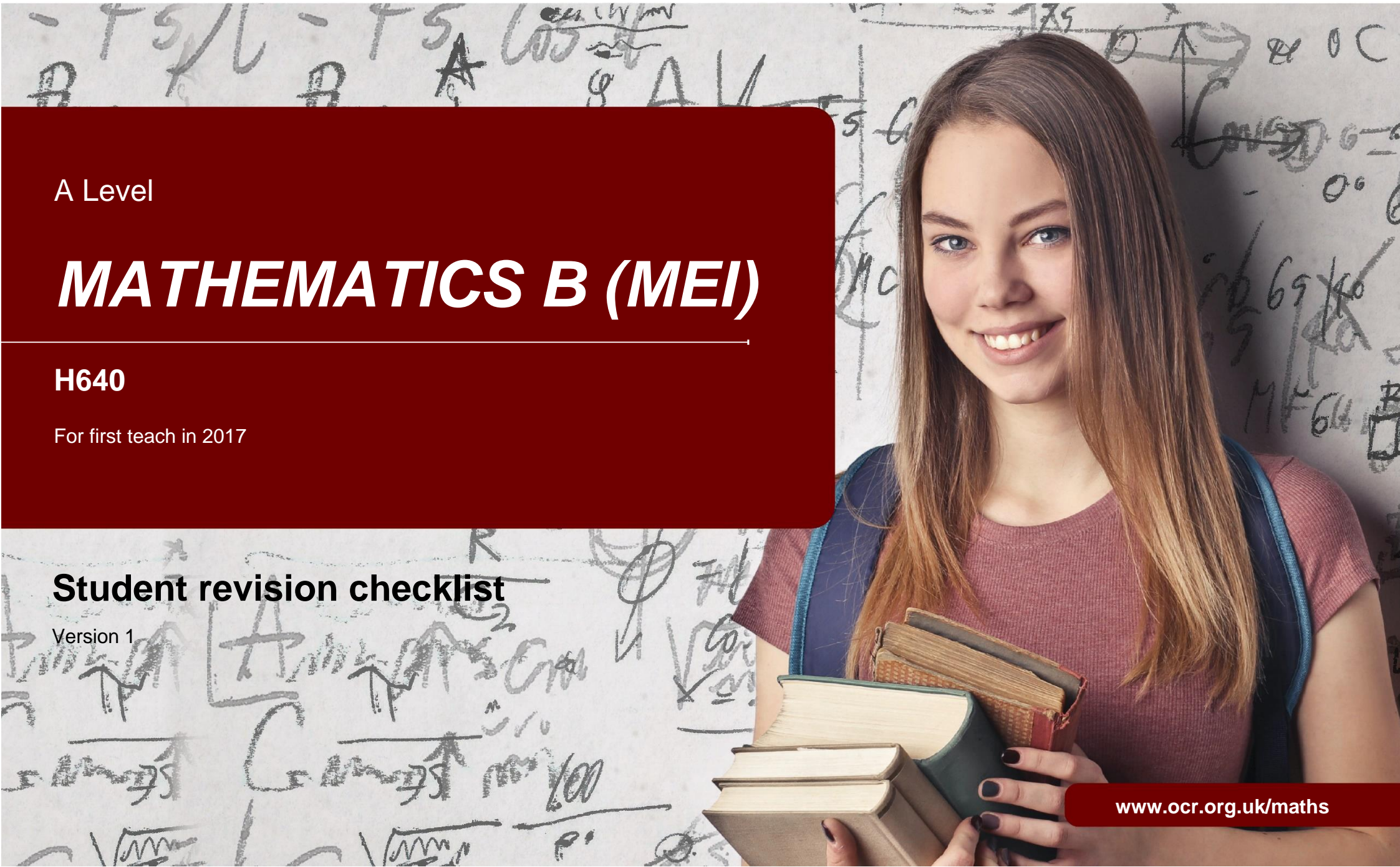MEI Innovators in Mathematics Education

A Level

MATHEMATICS B (MEI)

H640

For first teach in 2017

Student revision checklist

Version 1

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MATHEMATICS B (MEI)

Student revision checklist

A Level Mathematics B – H640

Revision checklists

The tables below can be used as a revision checklist. **It doesn't contain all the detailed knowledge you need to know, just an overview.**

For more information please see the OCR A Level Mathematics B specification.

The table headings are explained below:

You should be able to	Revision tips and practice materials	R	A	G	Comments
Here is a list of the skills you need to cover and work on.	You can use this column to add references for revision practice materials, such as: • Textbook page references • Teacher worksheets • OCR Section check in tests • MEI Integral exercises, summary sheets, progress tests and topic assessments.	You can use the tick boxes to show when you have revised an item and how confident you feel about it. R = **RED** means you are really unsure and lack confidence; you might want to focus your revision here and possibly talk to your teacher for help. A = **AMBER** means you are reasonably confident but need some extra practice. G = **GREEN** means you are very confident. As your revision progresses, you can concentrate on the **RED** and **AMBER** items in order to turn them into **GREEN** items. You might find it helpful to highlight each topic in red, orange or green to help you prioritise.			You can use the comments column to: • add more information about the details for each point • add formulae or notes • include a reference to a useful resource • highlight areas of difficulty or things that you need to talk to your teacher about or look up in a textbook.

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You should be able to (Topics)		Revision tips and practice materials	R	A	G	Comments
Proof:		Practise algebraic manipulation and the structuring of a mathematical proof				
Mp1)	Understand and be able to use the structure of mathematical proof. Use methods of proof, including proof by deduction and proof by exhaustion.					
Mp2)	Be able to disprove a conjecture by the use of a counter example.					
Mp3)	Understand and be able to use proof by contradiction.					
Algebra:		Practise algebraic manipulation and graphing equations and inequalities.				
Ma1)	Know and be able to use vocabulary and notation appropriate to the subject at this level.					$f(x)$
*)	Be able to solve linear equations in one unknown.					
*)	Be able to change the subject of a formula.					
Ma2)	Be able to solve quadratic equations.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Ma3) Be able to find the discriminant of a quadratic function and understand its significance.					For $ax^2 + bx + c = 0$ the discriminant is $b^2 - 4ac$. The condition for distinct real roots of $ax^2 + bx + c = 0$ is: Discriminant > 0. The condition for repeated roots is: Discriminant $= 0$. The condition for no real roots is: Discriminant < 0.
Ma4) Be able to solve linear simultaneous equations in two unknowns.					
Ma5) Be able to solve simultaneous equations in two unknowns with one equation linear and one quadratic.					
Ma6) Know the significance of points of intersection of two graphs with relation to the solution of equations.					
Ma7) Be able to solve linear inequalities in one variable. Be able to represent and interpret linear inequalities graphically e.g. $y > x + 1$.					
Ma8) Be able to solve quadratic inequalities in one variable. Be able to represent and interpret quadratic inequalities graphically e.g. $y > ax^2 + bx + c$.					

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Ma9) Be able to express solutions of inequalities through correct use of 'and' and 'or', or by using set notation.					$\{x : x > 4\}$
Ma10) Be able to use and manipulate surds.					
Ma11) Be able to rationalise the denominator of a surd.					
Ma12) Understand and be able to use the laws of indices for all rational exponents.					$x^a \times x^b = x^{a+b}$, $x^a \div x^b = x^{a-b}$, $(x^a)^n = x^{an}$
					$x^{-a} = \dfrac{1}{x^a}$, $x^0 = 1$ ($x \neq 0$), $x^{\frac{1}{a}} = \sqrt[a]{x}$
Ma13) Understand and be able to use negative, fractional and zero indices.					
Ma14) Understand and use proportional relationships and their graphs.					
Ma15) Be able to express algebraic fractions as partial fractions.					
Ma16) Be able to simplify rational expressions.					
Functions:	Practise algebraic manipulation and graphing functions.				
Mf1) Be able to add, subtract, multiply and divide polynomials.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mf2) Understand the factor theorem and be able to use it to factorise a polynomial or to determine its zeros.					$f(a)=0 \Leftrightarrow (x-a)$ is a factor of $f(x)$.
Mf3) Understand the definition of a function and be able to use the associated language.					Many-to-one, one-to-one, domain, range. $f:x \rightarrow y$
Mf4) Understand and use composite functions.					$gf(x)$
Mf5) Understand and be able to use inverse functions and their graphs. Know the conditions necessary for the inverse of a function to exist and how to find it.					$f^{-1}(x)$
Mf6) Understand and be able to use the modulus function.					
Mf7) Be able to solve simple inequalities containing a modulus sign.					
Mf8) Be able to use functions in modelling.					
Graphs:	Practise graphing and curve sketching.				
MC1) Understand and use graphs of functions.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MC2) Understand how to find intersection points of a curve with coordinate axes.					
MC3) Understand and be able to use the method of completing the square to find the line of symmetry and turning point of the graph of a quadratic function and to sketch a quadratic curve (parabola).					The curve $y = a(x+p)^2 + q$ has • a minimum at $(-p, \; q)$ for $a > 0$ or a maximum at $(-p, \; q)$ for $a < 0$ a line of symmetry $x = -p$.
MC4) Be able to sketch and interpret the graphs of simple functions including polynomials.					
MC5) Be able to use stationary points when curve sketching.					
MC6) Be able to sketch and interpret the graphs of $y = \dfrac{a}{x}$ and $y = \dfrac{a}{x^2}$.					
MC7) Be able to sketch curves of the forms $y = a\,\mathrm{f}(x)$, $y = \mathrm{f}(x) + a$, $y = \mathrm{f}(x+a)$ and $y = \mathrm{f}(ax)$, given the curve of $y = \mathrm{f}(x)$ and describe the associated transformations. Be able to form the equation of a graph following a single transformation.					Map(s) onto. Translation, stretch, reflection

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MC8) Understand the effect of combined transformations on a graph and be able to form the equation of the new graph and to sketch it. Be able to recognise the transformations that have been applied to a graph from the graph or its equation.					Vector notation may be used for a translation. $\begin{pmatrix} a \\ b \end{pmatrix}$, $a\mathbf{i} + b\mathbf{j}$
MC9) Be able to use stationary points of inflection when curve sketching.					
Coordinate Geometry:	Use graphing software to check your understanding of these concepts.				
*) Understand and use the equation $y = mx + c$					
Mg1) Know and be able to use the relationship between the gradients of parallel lines and perpendicular lines.					For parallel lines $m_1 = m_2$. For perpendicular lines $m_1 m_2 = -1$.
Mg2) Be able to calculate the distance between two points.					
Mg3) Be able to find the coordinates of the midpoint of a line segment joining two points.					
Mg4) Be able to form the equation of a straight line.					Including $y - y_1 = m(x - x_1)$, $ax + by + c = 0$ and $\dfrac{y - y_1}{y_2 - y_1} = \dfrac{x - x_1}{x_2 - x_1}$
Mg5) Be able to draw a line given its equation.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mg6) Be able to find the point of intersection of two lines.					
Mg7) Be able to use straight line models.					
Mg8) Be able to find the point(s) of intersection of a line and a curve or of two curves.					
Mg9) Be able to find the point(s) of intersection of a line and a circle.					
Mg10) Understand and use the equation of a circle in the form $(x-a)^2 + (y-b)^2 = r^2$.					
Mg11) Know and be able to use the following properties: • the angle in a semicircle is a right angle; • the perpendicular from the centre of a circle to a chord bisects the chord; • the radius of a circle at a given point on its circumference is perpendicular to the tangent to the circle at that point.					
Mg12) Understand the meaning of the terms parameter and parametric equations.					
Mg13) Be able to convert between cartesian and parametric forms of equations.					
Mg14) Understand and use the equation of a circle written in parametric form.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mg15) Be able to find the gradient of a curve defined in terms of a parameter by differentiation.					$\dfrac{dy}{dx} = \dfrac{\left(\dfrac{dy}{dt}\right)}{\left(\dfrac{dx}{dt}\right)}$
Mg16) Be able to use parametric equations in modelling.					
Sequences and Series:	Practise algebraic manipulation and working with formulae.				
Ms1) Understand and use the binomial expansion of $(a+bx)^n$ where n is a positive integer.					
Ms2) Know the notations $n!$ and $_nC_r$ and that $_nC_r$ is the number of ways of selecting r distinct objects from n.					$_nC_r = \dfrac{n!}{r!(n-r)!}$ $n! = 1.2.3...n$ $_nC_0 = {}_nC_n = 1$ $0! = 1$ $^nC_r, \begin{pmatrix} n \\ r \end{pmatrix}$
Ms3) Use the binomial expansion of $(1+x)^n$ where n is any rational number.					For $|x| < 1$ when n is not a positive integer.

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Ms4) Be able to write $(a+bx)^n$ in the form $a^n \left(1+\dfrac{bx}{a}\right)^n$ and hence expand $(a+bx)^n$.					$\left\lvert\dfrac{bx}{a}\right\rvert < 1$ when n is not a positive integer.
Ms5) Be able to use binomial expansions with n rational to find polynomials which approximate $(a+bx)^n$.					
Ms6) Know what a sequence of numbers is and the meaning of finite and infinite with reference to sequences.					
Ms7) Be able to generate a sequence using a formula for the kth term, or a recurrence relation of the form $a_{k+1} = \mathrm{f}(a_k)$.					kth term: a_k
Ms8) Know that a series is the sum of consecutive terms of a sequence.					
Ms9) Understand and use sigma notation.					$\displaystyle\sum_{r=1}^{n} r = 1+2+...+n$
Ms10) Be able to recognise increasing, decreasing and periodic sequences.					
Ms11) Know the difference between convergent and divergent sequences.					Limit to denote the value to which a sequence converges.

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Ms12) Understand and use arithmetic sequences and series.					The term arithmetic progression (AP) may also be used for an arithmetic sequence. First term, a Last term, l Common difference, d.
Ms13) Be able to use the standard formulae associated with arithmetic sequences and series.					The nth term, the sum to n terms. Including the sum of the first n natural numbers. S_n
Ms14) Understand and use geometric sequences and series.					The term geometric progression (GP) may also be used for a geometric sequence. First term, a Common ratio, r.
Ms15) Be able to use the standard formulae associated with geometric sequences and series.					The nth term, the sum to n terms. S_n
Ms16) Know the condition for a geometric series to be convergent and be able to find its sum to infinity.					$S_\infty = \dfrac{a}{1-r}, \ |r| < 1$
Trigonometry:	Use drawing and graphing software to check your understanding of these concepts.				

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
*) Know how to solve right-angled triangles using trigonometry.					
Mt1) Be able to use the definitions of $\sin\theta$, $\cos\theta$ and $\tan\theta$ for any angle.					By reference to the unit circle, $\sin\theta = y,\quad \cos\theta = x,\quad \tan\theta = \dfrac{y}{x}$.
Mt2) Know and use the graphs of $\sin\theta$, $\cos\theta$ and $\tan\theta$ for all values of θ, their symmetries and periodicities.					Period
*) Know and be able to use the exact values of $\sin\theta$ and $\cos\theta$ for $\theta = 0°, 30°, 45°, 60°$ and $90°$ and the exact values of $\tan\theta$ for $\theta = 0°, 30°, 45°$ and $60°$.					
Mt3) Know and be able to use the fact that the area of a triangle is given by $\frac{1}{2}ab\sin C$.					
Mt4) Know and be able to use the sine and cosine rules.					
Mt5) Understand and be able to use $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$.					
Mt6) Understand and be able to use the identity $\sin^2\theta + \cos^2\theta = 1$.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mt7) Be able to solve simple trigonometric equations in given intervals and know the principal values from the inverse trigonometric functions.					$\arcsin\theta \quad \sin^{-1}\theta$ $\arccos\theta \quad \cos^{-1}\theta$ $\arctan\theta \quad \tan^{-1}\theta$
Mt8) Know and be able to use exact values of $\sin\theta, \cos\theta, \tan\theta$ for $\theta = 0, \dfrac{\pi}{6}, \dfrac{\pi}{4}, \dfrac{\pi}{3}, \pi$ and multiples thereof and $\sin\theta, \cos\theta$ for $\theta = \dfrac{\pi}{2}$ and multiples thereof.					
Mt9) Understand and use the definitions of the functions arcsin, arccos and arctan, their relationship to sin, cos and tan, their graphs and their ranges and domains.					
Mt10) Understand and use the definition of a radian and be able to convert between radians and degrees.					A radian is the angle subtended at the centre of a circle by an arc of length equal to the radius of the circle.
Mt11) Know and be able to find the arc length and area of a sector of a circle, when the angle is given in radians.					The results $s = r\theta$ and $A = \frac{1}{2}r^2\theta$ where θ is measured in radians.
Mt12) Understand and use the standard small angle approximations of sine, cosine and tangent.					$\sin\theta \approx \theta, \ \cos\theta \approx 1 - \dfrac{\theta^2}{2}, \tan\theta \approx \theta$ where θ is in radians.

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mt13) Understand and use the definitions of the sec, cosec and cot functions.					
Mt14) Understand relationships between the graphs of the sin, cos, tan, cosec, sec and cot functions.					
Mt15) Understand and use the relationships $\tan^2\theta + 1 = \sec^2\theta$ and $\cot^2\theta + 1 = \csc^2\theta$.					
Mt16) Understand and use the identities for $\sin(\theta \pm \phi)$, $\cos(\theta \pm \phi)$, $\tan(\theta \pm \phi)$.					
Mt17) Know and use identities for $\sin 2\theta$, $\cos 2\theta$, $\tan 2\theta$.					Includes understanding derivations from $\sin(\theta + \phi)$, $\cos(\theta + \phi)$, $\tan(\theta + \phi)$. $\cos 2\theta = \cos^2\theta - \sin^2\theta$ $\cos 2\theta = 2\cos^2\theta - 1$ $\cos 2\theta = 1 - 2\sin^2\theta$
Mt18) Understand and use expressions for $a\cos\theta \pm b\sin\theta$ in the equivalent forms $R\sin(\theta \pm \alpha)$ and $R\cos(\theta \pm \alpha)$.					
Mt19) Use trigonometric identities, relationships and definitions in solving equations.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mt20) Construct proofs involving trigonometric functions and identities.					
Mt21) Use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces.					
Exponentials and Logarithms:	Practise algebraic manipulation and use graphing software to check your understanding of these concepts.				
ME1) Know and use the function $y = a^x$ and its graph. For $a > 0$.					
ME2) Be able to convert from an index to a logarithmic form and vice versa.			$x = a^y \Leftrightarrow y = \log_a x$ for $a > 0$ and $x > 0$.		
ME3) Understand a logarithm as the inverse of the appropriate exponential function and be able to sketch the graphs of exponential and logarithmic functions.			$y = \log_a x \Leftrightarrow a^y = x$ for $a > 0$ and $x > 0$.		

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
ME4) Understand the laws of logarithms and be able to apply them, including to taking logarithms of both sides of an equation.					$\log_a(xy) = \log_a x + \log_a y$ $\log_a\left(\dfrac{x}{y}\right) = \log_a x - \log_a y$ $\log_a(x^k) = k\log_a x$ Including, for example $k = -1$ and $k = -\frac{1}{2}$
ME5) Know and use the values of $\log_a a$ and $\log_a 1$.					$\log_a a = 1,\ \log_a 1 = 0$
ME6) Be able to solve an equation of the form $a^x = b$.					
ME7) Know how to reduce the equations $y = ax^n$ and $y = ab^x$ to linear form and, using experimental data, to use a graph to estimate values of the parameters.					
ME8) Know and be able to use the function $y = e^x$ and its graph.					
ME9) Know that the gradient of e^{kx} is ke^{kx} and hence understand why the exponential model is suitable in many applications.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
ME10) Know and be able to use the function $y = \ln x$ and its graph. Know the relationship between $\ln x$ and e^x.					$\ln x$ is the inverse function of e^x. $\log_e x = \ln x$ $\ln e = 1$ *and* $\ln 1 = 0$
ME11) Be able to solve problems involving exponential growth and decay; be able to consider limitations and refinements of exponential growth and decay models .					
Calculus:					
Mc1) Know and use that the gradient of a curve at a point is given by the gradient of the tangent at the point.					
Mc2) Know and use that the gradient of the tangent at a point A on a curve is given by the limit of the gradient of chord AP as P approaches A along the curve.					
Mc3) Understand and use the derivative of $f(x)$ as the gradient of the tangent to the graph of $y=f(x)$ at a general point (x, y). Know that the gradient function $\dfrac{dy}{dx}$ gives the gradient of the curve and measures the rate of change of y with respect to x.					$\dfrac{dy}{dx} = \lim_{\delta x \to 0} \dfrac{\delta y}{\delta x}$ $f'(x)=$ $\lim_{h \to 0} \left(\dfrac{f(x+h) - f(x)}{h} \right)$
Mc4) Be able to sketch the gradient function for a given curve.					$f''(x) = \dfrac{d^2 y}{dx^2}$

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mc5) Be able to differentiate $y = kx^n$ where k is a constant and n is rational, including related sums and differences.					
Mc6) Understand and use the second derivative as the rate of change of gradient.					$f''(x) = \dfrac{d^2 y}{dx^2}$
Mc7) Be able to use differentiation to find stationary points on a curve: maxima and minima.					
Mc8) Understand the terms increasing function and decreasing function and be able to find where the function is increasing or decreasing.					
Mc9) Be able to find the equation of the tangent and normal at a point on a curve.					
Mc10) Be able to differentiate e^{kx}, a^{kx} and $\ln x$.					
Mc11) Be able to differentiate the trigonometrical functions: $\sin kx$; $\cos kx$; $\tan kx$ for x in radians.					
Mc12) Be able to differentiate the product of two functions.					The product rule: $y = uv$, $\dfrac{dy}{dx} = u\dfrac{dv}{dx} + v\dfrac{du}{dx}$ $Or\ \left[f(x)g(x)\right]' = f(x)g'(x) + f'(x)g(x)$

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mc13) Be able to differentiate the quotient of two functions.					$y = \dfrac{u}{v}$, $\dfrac{dy}{dx} = \dfrac{v\dfrac{du}{dx} - u\dfrac{dv}{dx}}{v^2}$ $Or \left[\dfrac{f(x)}{g(x)}\right]' = \dfrac{g(x)f'(x) - f(x)g'(x)}{\left[g(x)\right]^2}$
Mc14) Be able to differentiate composite functions using the chain rule.					$y = f(u), \quad u = g(x), \quad \dfrac{dy}{dx} = \dfrac{dy}{du} \times \dfrac{du}{dx}$ or $\left\{f\left[g(x)\right]\right\}' = f'\left[g(x)\right]g'(x)$
Mc15) Be able to find rates of change using the chain rule, including connected rates of change and differentiation of inverse functions.					$\dfrac{dy}{dx} = \dfrac{1}{\left(\dfrac{dx}{dy}\right)}$
Mc16) Be able to differentiate a function or relation defined implicitly.					
Mc17) Understand that a section of curve which has increasing gradient (and so positive second derivative) is concave upwards. Understand that a section of curve which has decreasing gradient (and so negative second derivative) is concave downwards.					concave upwards (convex downwards) concave downwards (convex upwards)

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mc18) Understand that a point of inflection on a curve is where the curve changes from concave upwards to concave downwards (or vice versa) and hence that the second derivative at a point of inflection is zero. Be able to use differentiation to find stationary and non-stationary points of inflection.					
Mc19) Know that integration is the reverse of differentiation.					
Mc20) Be able to integrate functions of the form kx^n where k is a constant and $n \neq -1$.					
Mc21) Be able to find a constant of integration given relevant information.					
Mc22) Know what is meant by indefinite and definite integrals. Be able to evaluate definite integrals.					
Mc23) Be able to use integration to find the area between a graph and the x-axis.					
Mc24) Be able to integrate $e^{kx}, \dfrac{1}{x}, \sin kx, \cos kx$ and related sums, differences and constant multiples.					$\displaystyle\int \frac{1}{x}\,\mathrm{d}x = \ln|x| + c, \quad x \neq 0$ x in radians for trigonometrical integrals.

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mc25) Understand integration as the limit of a sum.					Know that $\displaystyle\lim_{\delta x \to 0} \sum_a^b f(x)\delta x = \int_a^b f(x)\mathrm{d}x$
Mc26) Be able to use integration to find the area between two curves.					
Mc27) Be able to use integration by substitution in cases where the process is the reverse of the chain rule (including finding a suitable substitution).					
Mc28) Be able to use integration by substitution in other cases.					
Mc29) Be able to use the method of integration by parts in simple cases.					
Mc30) Be able to integrate using partial fractions that are linear in the denominator.					
Mc31) Be able to formulate first order differential equations using information about rates of change.					
Mc32) Be able to find general or particular solutions of first order differential equations analytically by separating variables.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mc33) Be able to interpret the solution of a differential equation in the context of solving a problem, including identifying limitations of the solution.					
Numerical Methods:	Use spreadsheets and calculator functions to check answers and your understanding of these concepts.				
Me1) Be able to locate the roots of $f(x) = 0$ by considering changes of sign of $f(x)$ in an interval of x in which $f(x)$ is sufficiently well-behaved.					
Me2) Be aware of circumstances under which change of sign methods may fail.					
Me3) Be able to carry out a fixed point iteration after rearranging an equation into the form $x = g(x)$ and be able to draw associated staircase and cobweb diagrams.					
Me4) Be able to use the Newton-Raphson method to find a root of an equation and represent the process on a graph.					
Me5) Understand that not all iterations converge to a particular root of an equation.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mc34) Be able to find an approximate value of a definite integral using the trapezium rule, and decide whether it is an over- or an under-estimate.					
Mc35) Use the sum of a series of rectangles to find an upper and/or lower bound on the area under a curve.					
Me6) Use numerical methods to solve problems in context.					
Vectors:	Practise drawing diagrams to help aid understanding.				
Mv1) Understand the language of vectors in two dimensions.					Scalar, vector, modulus, magnitude, direction, position vector, unit vector, cartesian components, equal vectors, parallel vectors, collinear. Vectors printed in **bold**. Unit vectors $\mathbf{i}$, $\mathbf{j}$, $\hat{\mathbf{r}}$ The magnitude of the vector $\mathbf{a}$ is written $|\mathbf{a}|$ or a. $\mathbf{a} = \begin{pmatrix} a_1 \\ a_2 \end{pmatrix}$
Mv2) Be able to add and subtract vectors using a diagram or algebraically, multiply a vector by a scalar, and express a vector as a combination of others.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mv3) Be able to calculate the magnitude and direction of a vector and convert between component form and magnitude-direction form.					
Mv4) Understand and use position vectors.					$\overrightarrow{OB}$ or $\mathbf{b}$. $$\mathbf{r} = \begin{pmatrix} x \\ y \end{pmatrix}$$
Mv5) Be able to calculate the distance between two points represented by position vectors.					
Mv6) Be able to use vectors to solve problems in pure mathematics and in context, including problems involving forces.					
Mv7) Understand the language of vectors in three dimensions.					
Sampling:	Use the LDS to practise taking representative and biased samples.				

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mp21) Understand and use the terms population and sample.					**Population** in statistics means all the individuals we are interested in for a particular investigation e.g. all cod in an area of the sea. A population can be infinite e.g. all possible tosses of a particular coin. A probability distribution can be used to model some characteristic of the population which is of interest e.g. a Normal distribution could be used to model lengths of cod. A **sample** is a set of items chosen from a population. When sampling from an infinite population it does not matter whether the sampling is with or without replacement. When taking a sample of individuals, e.g. for a sample survey, it is usual to sample without replacement to avoid getting data from the same individual more than once.
Mp22) Be able to use samples to make informal inferences about a population, recognising that different samples might lead to different conclusions.					
Mp23) Understand and be able to use the concept of random sampling.					Every sample of the required size has the same probability of being selected.

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mp24) Understand and be able to use a variety of sampling techniques.					Opportunity sampling, systematic sampling, stratified sampling, quota sampling, cluster sampling, self-selected samples.
Mp25) Be able to select or evaluate sampling techniques in the context of solving a statistical problem.					
Data Presentation and Interpretation:	Investigate different features of the LDS using graphs and statistical calculations. Use spreadsheets to analyse the data and create statistical diagrams.				
MD1) Be able to recognise and work with categorical, discrete, continuous and ranked data. Be able to interpret standard diagrams for grouped and ungrouped single-variable data.					Includes knowing this vocabulary and deciding what data presentation methods are appropriate: bar chart, dot plot, histogram, vertical line chart, pie chart, stem-and-leaf diagram, box-and-whisker diagram (box plot), frequency chart. A frequency chart resembles a histogram with equal width bars but its vertical axis is frequency. A dot plot is similar to a bar chart but with stacks of dots in lines to represent frequency.

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MD2) Understand that the area of each bar in a histogram is proportional to frequency. Be able to calculate proportions from a histogram and understand them in terms of estimated probabilities.					
MD3) Be able to interpret a cumulative frequency diagram.					
MD4) Be able to describe frequency distributions.					Symmetrical, unimodal, bimodal, skewed (positively and negatively).
MD5) Understand that diagrams representing unbiased samples become more representative of theoretical probability distributions with increasing sample size.					**Bivariate data** consists of two variables for each member of the population or sample. An **association** between the two variables is some kind of relationship between them. **Correlation** measures linear relationships.
MD6) Be able to interpret a scatter diagram for bivariate data, interpret a regression line or other best fit model, including interpolation and extrapolation, understanding that extrapolation might not be justified.					An outlier is an item which is inconsistent with the rest of the data.
MD7) Be able to recognise when a scatter diagram appears to show distinct sections in the population. Be able to recognise and comment on outliers in a scatter diagram.					Positive correlation, negative correlation, no correlation, weak/strong correlation.

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MD8) Be able to recognise and describe correlation in a scatter diagram and understand that correlation does not imply causation.					Positive correlation, negative correlation, no correlation, weak/strong correlation.
MD9) Be able to select or critique data presentation techniques in the context of a statistical problem.					
MD10) Know the standard measures of central tendency and be able to calculate and interpret them and to decide when it is most appropriate to use one of them.					Median, mode, (arithmetic) mean, midrange. Mean $= \bar{x}$
MD11) Know simple measures of spread and be able to use and interpret them appropriately.					Range, percentiles, quartiles, interquartile range.
MD12) Know how to calculate and interpret variance and standard deviation for raw data, frequency distributions, grouped frequency distributions. Be able to use the statistical functions of a calculator to find mean and standard deviation.					sample variance: $s^2 = \dfrac{S_{xx}}{n-1}$ where $S_{xx} = \sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2$ sample standard deviation: $s = \sqrt{\text{variance}}$

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MD13) Understand the term outlier and be able to identify outliers. Know that the term outlier can be applied to an item of data which is: • at least 2 standard deviations from the mean; OR • at least 1.5 × IQR beyond the nearer quartile.					
MD14) Be able to clean data including dealing with missing data, errors and outliers.					
Probability:	Conduct mini-experiments using the random number generator function in spreadsheets.				
*) Be able to calculate the probability of an event.					$\mathrm{P}(A)$
*) Understand the concept of a complementary event and know that the probability of an event may be found by means of finding that of its complementary event.					$A´$ is the event "not-A".
*) Be able to calculate the expected frequency of an event given its probability.					Expected frequency $= n\mathrm{P}(A)$
*) Be able to use appropriate diagrams to assist in the calculation of probabilities.					
Mu1) Understand and use mutually exclusive events and independent events.					

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mu2) Know to add probabilities for mutually exclusive events.					
Mu3) Know to multiply probabilities for independent events.					
Mu4) Understand and use mutually exclusive events and independent events and associated notation and definitions.					For mutually exclusive events $P(A \cap B) = 0$ for any pair of events.
Mu5) Be able to use Venn diagrams to assist in the calculations of probabilities. Know how to calculate probabilities for two events which are not mutually exclusive.					$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
Mu6) Be able to calculate conditional probabilities by formula, from tree diagrams, two-way tables, Venn diagrams or sample space diagrams.					$P(A \mid B) = \dfrac{P(A \cap B)}{P(B)}$
Mu7) Know that $P(B|A) = P(B) \Leftrightarrow B$ and A are independent.					$P(A \cap B) = P(A) . P(B)$
Probability Distributions:	Conduct mini-experiments using the random number generator function in spreadsheets.				
MR1) Recognise situations which give rise to a binomial distribution.					
MR2) Be able to identify the probability of success, p, for the binomial distribution.					$B(n, p), \ q = 1 - p$ ~ means 'has the distribution'

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MR3) Be able to calculate probabilities using the binomial distribution.					
MR4) Understand and use mean $= np$.					
MR5) Be able to calculate expected frequencies associated with the binomial distribution.					
MR6) Be able to use probability functions, given algebraically or in tables. Know the term discrete random variable.					X for the random variable. x or r for a value of the random variable.
MR7) Be able to calculate the numerical probabilities for a simple distribution. Understand the term discrete uniform distribution.					$\mathrm{P}(X = x)$ $\mathrm{P}(X \leq x)$
MR8) Be able to use the Normal distribution as a model.					$X \sim \mathrm{N}(\mu, \sigma^2)$
MR9) Know the shape of the Normal curve and understand that histograms from increasingly large samples from a Normal distribution tend to the Normal curve.					The area under the Normal curve represents probability.

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MR10) Know that linear transformation of a Normal variable gives another Normal variable and know how the mean and standard deviation are affected. Be able to standardise a Normal variable.					$y_i = a + bx_i \Rightarrow \overline{y} = a + b\overline{x}$, $s_y^2 = b^2 s_x^2$ Standard Normal $Z \sim N(0,1)$ $Z = \dfrac{X - \mu}{\sigma}$
MR11) Know that the line of symmetry of the Normal curve is located at the mean and the points of inflection are located one standard deviation away from the mean.					
MR12) Be able to calculate and use probabilities from a Normal distribution.					
MR13) Be able to model with probability and probability distributions, including recognising when the binomial or Normal model may not be appropriate.					
Statistical Hypothesis Testing:	Practise setting out questions; state the hypotheses, test and conclude.				

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MH1) Understand the process of hypothesis testing and the associated language.					Null hypothesis, alternative hypothesis. Significance level, test statistic, 1-tail test, 2-tail test. Critical value, critical region (rejection region), acceptance region, p-value. The null hypothesis for a hypothesis test is the default position which will only be rejected in favour of the alternative hypothesis if the evidence is strong enough. Assuming the null hypothesis is true, as a default position, allows the calculation of values of the test statistic which would be unlikely (have low probability) if the null hypothesis were true; this is the critical region (rejection region).
MH2) Understand when to apply 1-tail and 2-tail tests.					
MH3) Understand that a sample is being used to make an inference about the population and appreciate that the significance level is the probability of incorrectly rejecting the null hypothesis.					
MH4) Be able to identify null and alternative hypotheses (H_0 and H_1) when setting up a hypothesis test based on a binomial probability model.					H_0 of form $p =$ a particular value, with p a probability for the whole population.

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MH5) Be able to conduct a hypothesis test at a given level of significance. Be able to draw a correct conclusion from the results of a hypothesis test based on a binomial probability model and interpret the results in context.					
MH6) Be able to identify the critical and acceptance regions.					
MH7) Know that random samples of size n from $X \sim \mathrm{N}(\mu, \sigma^2)$ have the sample mean Normally distributed with mean μ and variance $\dfrac{\sigma^2}{n}$.					Sample mean, $\overline{X}$ Particular value of sample mean, $\overline{x}$ Population mean, μ
MH8) Be able to carry out a hypothesis test for a single mean using the Normal distribution and be able to interpret the results in context.					
MH9) Be able to identify the critical and acceptance regions.					
MH10) Understand correlation as a measure of how close data points lie to a straight line. Understand that a rank correlation coefficient measures the correlation between the data ranks rather than actual data values.					r

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MH11) Be able to use a given correlation coefficient for a sample to make an inference about correlation or association in the population for given p-value or critical value.					Association refers to a more general relationship between the variables.
Models and Quantities:	Learn the definitions and units.				
Mp31) Know the language used to describe simplifying assumptions in mechanics.					Including the words: light; smooth; uniform; particle; inextensible; thin; rigid; long term.
Mp32) Understand and use the particle model.					
Mp33) Understand and use fundamental quantities and units in the S.I. system: length, time, mass.					Metre (m), kilogram (kg), second (s).
Mp34) Understand and use derived quantities and units: velocity, acceleration, force, weight.					Metre per second (m s^{-1}), metre per second per second (m s^{-2}), newton (N).
Mp35) Understand and use derived quantities and units: moment.					Newton metre (N m).

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Kinematics in 1 Dimension:	Conduct real and virtual experiments to help aid understanding.				
Mk1) Understand and use the language of kinematics.					Position, displacement, distance travelled; speed, velocity; acceleration, magnitude of acceleration; relative velocity (in 1-dimension). Average speed = distance travelled ÷ elapsed time Average velocity = overall displacement ÷ elapsed time
Mk2) Know the difference between position, displacement, distance and distance travelled.					
Mk3) Know the difference between velocity and speed, and between acceleration and magnitude of acceleration.					
Mk4) Be able to draw and interpret kinematics graphs for motion in a straight line, knowing the significance (where appropriate) of their gradients and the areas underneath them.					Position-time, displacement-time, distance-time, velocity-time, speed-time, acceleration-time.
Mk5) Be able to differentiate position and velocity with respect to time and know what measures result.					

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mk6) Be able to integrate acceleration and velocity with respect to time and know what measures result.					
Mk7) Be able to recognise when the use of constant acceleration formulae is appropriate.					
Mk8) Be able to solve kinematics problems using constant acceleration formulae and calculus for motion in a straight line.					
Mk9) Understand the language of kinematics appropriate to motion in 2 dimensions. Know the difference between, displacement, distance from and distance travelled; velocity and speed, and between acceleration and magnitude of acceleration.					Position vector, relative position. Average speed = distance travelled ÷ elapsed time Average velocity = overall displacement ÷ elapsed time
Mk10) Be able to extend the scope of techniques from motion in 1 dimension to that in 2 dimensions by using vectors.					$\mathbf{a} = \dot{\mathbf{v}} = \dfrac{d\mathbf{v}}{dt}, \mathbf{v} = \dot{\mathbf{r}} = \dfrac{d\mathbf{r}}{dt}$ $\mathbf{r} = \int \mathbf{v}dt, \mathbf{v} = \int \mathbf{a}dt$ $\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$ $\mathbf{s} = \mathbf{v}t - \frac{1}{2}\mathbf{a}t^2$ $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ $\mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$

A LEVEL
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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mk11) Be able to find the cartesian equation of the path of a particle when the components of its position vector are given in terms of time.					
Mk12) Be able to use vectors to solve problems in kinematics.					
Projectiles:	Conduct real and virtual experiments to help aid understanding.				
My1) Be able to model motion under gravity in a vertical plane using vectors. Be able to formulate the equations of motion of a projectile using vectors.					Standard modelling assumptions for projectile motion are as follows. • No air resistance. • The projectile is a particle. • Horizontal distance travelled is small enough to assume that gravity is always in the same direction. Vertical distance travelled is small enough to assume that gravity is constant.
My2) Know how to find the position and velocity at any time of a projectile and find range and maximum height.					
My3) Be able to find the initial velocity of a projectile given sufficient information.					

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
My4) Be able to eliminate time from the component equations that give the horizontal and vertical displacement in terms of time to obtain the equation of the trajectory.					
My5) Be able to solve simple problems involving projectiles.					
Forces:	Conduct real and virtual experiments to help aid understanding.				
MF1) Understand the language relating to forces.					Weight, tension, thrust or compression, normal reaction (or normal contact force), frictional force, resistance, driving force.
MF2) Know that the acceleration due to gravity is not a universal constant but depends on location in the universe. Know that on earth, the acceleration due to gravity is often modelled to be a constant, g m s^{-2}.					$g \approx 10$, $g \approx 9.8$ Acceleration due to gravity, g m s^{-2}.
MF3) Be able to identify the forces acting on a system and represent them in a force diagram. Understand the difference between external and internal forces and be able to identify the forces acting on part of the system.					

A LEVEL
MATHEMATICS B (MEI)

You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MF4) Be able to find the resultant of several concurrent forces when the forces are parallel or in two perpendicular directions or in simple cases of forces given as 2-D vectors in component form.					
MF5) Understand the concept of equilibrium and know that a particle is in equilibrium if and only if the vector sum of the forces acting on it is zero in the cases where the forces are parallel or in two perpendicular directions or in simple cases of forces given as 2-D vectors in component form.					
MF6) Be able to resolve a force into components and be able to select suitable directions for resolution. Be able to find the resultant of several concurrent forces by resolving and adding components.					
MF7) Know that a particle is in equilibrium if and only if the resultant of the forces acting on it is zero. Know that a body is in equilibrium under a set of concurrent forces if and only if their resultant is zero.					
MF8) Know that vectors representing a set of forces in equilibrium sum to zero. Know that a closed figure may be drawn to represent the addition of the forces on an object in equilibrium.					

A LEVEL
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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MF9) Be able to formulate and solve equations for a particle in equilibrium: by resolving forces in suitable directions; by drawing and using a polygon of forces.					
MF10) Understand that the overall contact force between surfaces may be expressed in terms of a frictional force and a normal contact force and be able to draw an appropriate force diagram. Understand that the normal contact force cannot be negative.					
MF11) Understand that the frictional force may be modelled by $F \leq \mu R$ and that friction acts in the direction to oppose sliding. Model friction using $F = \mu R$ when sliding occurs.					Coefficient of friction $= \mu$ Limiting friction static equilibrium
MF12) Be able to apply Newton's Laws to problems involving friction.					
Newton's Laws of Motion:	Conduct real and virtual experiments to help aid understanding.				
Mn1) Know and understand the meaning of Newton's three laws.					
Mn2) Understand the term equation of motion.					

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
Mn3) Be able to formulate the equation of motion for a particle moving in a straight line when the forces acting are parallel or in two perpendicular directions or in simple cases of forces given as 2-D vectors in component form.					$F = ma$ where F is the resultant force. $\mathbf{F} = m\mathbf{a}$ where $\mathbf{F}$ is the resultant force.
Mn4) Be able to model a system as a set of connected particles.					
Mn5) Be able to formulate the equations of motion for the individual particles within the system.					
Mn6) Know that a system in which none of its components have any relative motion may be modelled as a single particle with the mass of the system.					
Mn7) Be able to formulate the equation of motion for a particle moving in a straight line or in a plane.					$F = ma$ where F is the resultant force. $\mathbf{F} = m\mathbf{a}$ where $\mathbf{F}$ is the resultant force.
Rigid Bodies:	Conduct real and virtual experiments to help aid understanding.				
MF13) Be able to calculate the moment of a force about a point or axis.					Units of moment are $\mathrm{N\ m}$.

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You should be able to (Topics)	Revision tips and practice materials	R	A	G	Comments
MF14) Understand that a rigid body is in equilibrium when the resultant force is zero and the sum of the moments about any one point is zero.					
MF15) Understand that a system of forces can have a turning effect on a rigid body.					Moment
MF16) Know that, for the purpose of calculating its moment, the weight of a body can be taken as acting through a point.					The point is the centre of mass of the body. Uniform

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You should be able to (Assessment Objectives)		Revision tips	R	A	G	Comments
AO1.1a	Select routine procedures	Read exam questions carefully to identify the topics being assessed.				
AO1.1b	Correctly carry out routine procedures	Practise the questions that appear at the start of each exercise in the textbook as these will be more procedural.				
AO1.2	Accurately recall facts, terminology and definitions	Produce your own glossary of mathematical facts and definitions.				
AO2.1	Construct rigorous mathematical arguments (including proofs)	Set out your work neatly and avoid missing out logical steps in your working.				
AO2.2a	Make deductions from known results to correct conclusions	Always link the calculated answer back to the context given in the question.				
AO2.2b	Make inferences from relative or partial evidence to results that are likely to be correct	Always consider what your answer means in real life and how the answer should be interpreted in the context given in the question.				
AO2.3	Assess the validity of mathematical arguments by identifying any errors/omissions or by finding the conditions under which the argument remains correct	Check that your answer makes sense and consider when other factors may negate that answer.				
AO2.4	Explain the reasoning by providing justification for key steps	Set out work neatly, showing each of the required steps in the calculation to justify your answer.				

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You should be able to (Assessment Objectives)		Revision tips	R	A	G	Comments
AO2.5	Use mathematical language and notation correctly	Only use accepted abbreviations and notations, these are listed in section 5c of the specification.				
AO3.1a	Translate problems in mathematical contexts into mathematical processes	Read exam questions carefully to identify the topics being assessed.				
AO3.1b	Translate problems in non-mathematical contexts into mathematical processes	Practise the questions that appear at the end of each exercise in the textbook as these will be more rigorous.				
AO3.2a	Interpret solutions to problems in their original context	State your answer in the context given in the question.				
AO3.2b	Evaluate the accuracy and limitations of any solutions	Check that your answer makes sense in the context of the question and consider when other factors may negate that answer.				
AO3.3	Translate situations in context into mathematical models	Read exam questions carefully to identify the topics being assessed.				
AO3.4	Use mathematical models	Practise all of the mathematical models defined in the specification.				
AO3.5a	Evaluate the outcomes of modelling in context	Check that your answer makes sense in the context of the question and consider when other factors may negate that answer.				
AO3.5b	Recognise the limitations of models	Consider the assumptions used when using any mathematical model.				

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You should be able to (Assessment Objectives)	Revision tips	R	A	G	Comments
AO3.5c Explain how a model could be refined (improved)	State your answer in the context given in the question.				

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Mathematical Formulae and identities

You must be able to use the following formulae and identities for A Level mathematics, without these formulae and identities being provided, either in these forms or in equivalent forms. These formulae and identities may only be provided where they are the starting point for a proof or as a result to be proved.

Pure Mathematics

Quadratic Equations

$ax^2 + bx + c = 0$ has roots $\dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Laws of Indices

$a^x a^y \equiv a^{x+y}$

$a^x \div a^y \equiv a^{x-y}$

$(a^x)^y \equiv a^{xy}$

Laws of Logarithms

$x = a^n \Leftrightarrow n = \log_a x$ for $a > 0$ and $x > 0$

$\log_a x + \log_a y \equiv \log_a (xy)$

$\log_a x - \log_a y \equiv \log_a \left(\dfrac{x}{y} \right)$

$k \log_a x \equiv \log_a \left(x^k \right)$

Coordinate Geometry

A straight line graph, gradient m passing through (x_1, y_1) has equation

$y - y_1 = m(x - x_1)$

Straight lines with gradients m_1 and m_2 are perpendicular when $m_1 m_2 = -1$

A LEVEL
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Sequences

General term of an arithmetic progression:

$$u_n = a + (n-1)d$$

General term of a geometric progression:

$$u_n = ar^{n-1}$$

Trigonometry

In the triangle ABC

Sine rule: $\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$

Cosine rule: $a^2 = b^2 + c^2 - 2bc \cos A$

Area $= \dfrac{1}{2} ab \sin C$

$\cos^2 A + \sin^2 A \equiv 1$
$\sec^2 A \equiv 1 + \tan^2 A$
$\operatorname{cosec}^2 A \equiv 1 + \cot^2 A$

$\sin 2A \equiv 2 \sin A \cos A$
$\cos 2A \equiv \cos^2 A - \sin^2 A$

$\tan 2A \equiv \dfrac{2 \tan A}{1 - \tan^2 A}$

Mensuration

Circumference and Area of circle, radius r and diameter d:

$$C = 2\pi r = \pi d \qquad A = \pi r^2$$

Pythagoras' Theorem: In any right-angled triangle where a, b and c are the lengths of the sides and c is the hypotenuse:

$$c^2 = a^2 + b^2$$

Area of a trapezium $= \dfrac{1}{2}(a+b)h$, where a and b are the lengths of the parallel sides and h is their perpendicular separation.

Volume of a prism = area of cross section × length

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For a circle of radius r, where an angle at the centre of θ radians subtends an arc of length s and encloses an associated sector of area A:

$$s = r\theta \quad A = \frac{1}{2}r^2\theta$$

Calculus and Differential Equations

Differentiation

Function	Derivative
x^n	nx^{n-1}
$\sin kx$	$k\cos kx$
$\cos kx$	$-k\sin kx$
e^{kx}	ke^{kx}
$\ln x$	$\dfrac{1}{x}$
$f(x)+g(x)$	$f'(x)+g'(x)$
$f(x)g(x)$	$f'(x)g(x)+f(x)g'(x)$
$f(g(x))$	$f'(g(x))g'(x)$

Integration

Function	Integral
x^n	$\dfrac{1}{n+1}x^{n+1}+c, \; n \neq -1$
$\cos kx$	$\dfrac{1}{k}\sin kx + c$
$\sin kx$	$-\dfrac{1}{k}\cos kx + c$
e^{kx}	$\dfrac{1}{k}e^{kx}+c$
$\dfrac{1}{x}$	$\ln|x|+c, \; x \neq 0$
$f'(x)+g'(x)$	$f(x)+g(x)+c$
$f'(g(x))g'(x)$	$f(g(x))+c$

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Area under a curve $= \int_a^b y \, \mathrm{d}x \ (y \geq 0)$

Vectors

$|x\mathbf{i} + y\mathbf{j} + z\mathbf{k}| = \sqrt{x^2 + y^2 + z^2}$

Mechanics

Forces and Equilibrium

Weight = mass $\times g$

Friction: $F \leq \mu R$

Newton's second law in the form: $F = ma$

Kinematics

For motion in a straight line with variable acceleration:

$$v = \frac{\mathrm{d}r}{\mathrm{d}t} \qquad a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 r}{\mathrm{d}t^2}$$

$$r = \int v \, \mathrm{d}t \qquad v = \int a \, \mathrm{d}t$$

Statistics

The mean of a set of data: $\bar{x} = \dfrac{\sum x}{n} = \dfrac{\sum fx}{\sum f}$

The standard Normal variable: $Z = \dfrac{X - \mu}{\sigma}$ where $X \sim N\left(\mu, \sigma^2\right)$

A LEVEL
MATHEMATICS B (MEI)

You will be given the following formulae sheet in each question paper:

Formulae A Level Mathematics B (MEI) (H640)

Arithmetic series

$S_n = \tfrac{1}{2}n(a+l) = \tfrac{1}{2}n\{2a+(n-1)d\}$

Geometric series

$S_n = \dfrac{a(1-r^n)}{1-r}$

$S_\infty = \dfrac{a}{1-r} \quad$ for $|r| < 1$

Binomial series

$(a+b)^n = a^n + {}^nC_1\, a^{n-1}b + {}^nC_2\, a^{n-2}b^2 + \ldots + {}^nC_r\, a^{n-r}b^r + \ldots + b^n \qquad (n \in \Box)$,

where ${}^nC_r = \dbinom{n}{r} = \dfrac{n!}{r!(n-r)!}$

$(1+x)^n = 1 + nx + \dfrac{n(n-1)}{2!}x^2 + \ldots + \dfrac{n(n-1)\ldots(n-r+1)}{r!}x^r + \ldots \quad \left(|x|<1,\ n \in \Box\right)$

Differentiation

$f(x)$	$f'(x)$
$\tan kx$	$k\sec^2 kx$
$\sec x$	$\sec x \tan x$
$\cot x$	$-\operatorname{cosec}^2 x$
$\operatorname{cosec} x$	$-\operatorname{cosec} x \cot x$

Quotient Rule $\quad y = \dfrac{u}{v}, \ \dfrac{dy}{dx} = \dfrac{v\dfrac{du}{dx} - u\dfrac{dv}{dx}}{v^2}$

Differentiation from first principles

$f'(x) = \lim\limits_{h \to 0} \dfrac{f(x+h) - f(x)}{h}$

Integration

$\displaystyle\int \dfrac{f'(x)}{f(x)}\,dx = \ln|f(x)| + c$

$\displaystyle\int f'(x)(f(x))^n\,dx = \dfrac{1}{n+1}(f(x))^{n+1} + c$

Integration by parts $\displaystyle\int u\dfrac{dv}{dx}\,dx = uv - \int v\dfrac{du}{dx}\,dx$

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MATHEMATICS B (MEI)

Small angle approximations

$\sin\theta \approx \theta,\quad \cos\theta \approx 1-\tfrac{1}{2}\theta^2,\quad \tan\theta \approx \theta$ where θ is measured in radians

Trigonometric identities

$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$

$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$

$\tan(A \pm B) = \dfrac{\tan A \pm \tan B}{1 \mp \tan A \tan B} \qquad (A \pm B \neq (k+\tfrac{1}{2})\pi)$

Numerical methods

Trapezium rule: $\displaystyle\int_a^b y\,dx \approx \tfrac{1}{2}h\{(y_0 + y_n) + 2(y_1 + y_2 + \ldots + y_{n-1})\}$, where $h = \dfrac{b-a}{n}$

The Newton-Raphson iteration for solving $f(x) = 0$: $x_{n+1} = x_n - \dfrac{f(x_n)}{f'(x_n)}$

Probability

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$P(A \cap B) = P(A)P(B \mid A) = P(B)P(A \mid B) \quad$ **or** $\quad P(A \mid B) = \dfrac{P(A \cap B)}{P(B)}$

Sample variance

$s^2 = \dfrac{1}{n-1}S_{xx}$ where $S_{xx} = \sum(x_i - \bar{x})^2 = \sum x_i^2 - \dfrac{\left(\sum x_i\right)^2}{n} = \sum x_i^2 - n\bar{x}^2$

Standard deviation, $s = \sqrt{\text{variance}}$

The binomial distribution

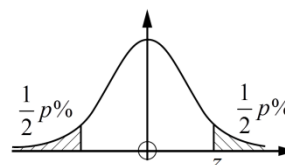If $X \sim B(n,\ p)$ then $P(X = r) = {}^nC_r\, p^r q^{n-r}$ where $q = 1 - p$ $\qquad$ Mean of X is np

Hypothesis testing for the mean of a Normal distribution

If $X \sim N\left(\mu,\ \sigma^2\right)$ then $\bar{X} \sim N\left(\mu,\ \dfrac{\sigma^2}{n}\right)$ and $\dfrac{\bar{X} - \mu}{\sigma/\sqrt{n}} \sim N(0,\ 1)$

Percentage points of the Normal distribution

p	10	5	2	1
z	1.645	1.960	2.326	2.576

A LEVEL
MATHEMATICS B (MEI)

Kinematics

Motion in a straight line

Motion in two dimensions

$v = u + at$

$\mathbf{v} = \mathbf{u} + \mathbf{a}t$

$s = ut + \frac{1}{2}at^2$

$\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$

$s = \frac{1}{2}(u+v)t$

$\mathbf{s} = \frac{1}{2}(\mathbf{u}+\mathbf{v})t$

$v^2 = u^2 + 2as$

$s = vt - \frac{1}{2}at^2$

$\mathbf{s} = \mathbf{v}t - \frac{1}{2}\mathbf{a}t^2$

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