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Comparison guide

OxfordAQA AS/A-level Mathematics Specification (9660) with the US High School Curriculum

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OxfordAQA is a partnership between AQA, the UK's largest awarding body, and Oxford University Press, a department of the University of Oxford. We offer globally relevant international GCSEs, AS and A-levels in the Middle East, the Gulf, East Asia and South East Asia.

Introduction and Commentary

Distinctives

There is more content in the OxfordAQA Spec reflecting the fact that the UK curriculum studies fewer subjects but does so in greater depth and breadth than the US High School curriculum.

US High School Common Core State Standards for Mathematics (US HS CCSS)	**Oxford AQA International AS and A-level Mathematics (9660) Specification (OxfordAQA Spec)**
The Standards consist of five main sections at High School level. They are: 1. Number and Quantity 2. Algebra 3. Functions 4. Modeling 5. Geometry 6. Statistics and Probability	The specification is divided into five units or modules. They are: 1. Unit P1 (Pure Maths) 2. Unit PSM1 (Pure Maths, Statistics and Mechanics) 3. Unit P2 (Pure Maths) 4. Unit S2 (Statistics) 5. Unit M2 (Mechanics)
The high-school maths curriculum covers the four years of high school and is split by topic rather than by grade/year – so there is no set curriculum aimed solely at the AS/A-level equivalent years (Grades 11-12)	Coverage of P1 and PSM1 is required for the AS award. For the full A-level award coverage of Unit P2 (Pure Maths) is required supplemented either by Unit S2 (Statistics) or Unit M2 (Mechanics).

US HS CCSS conceptual categories

As can be seen in the tables below there is considerable common ground between the pure mathematics in the first three modules of the OxfordAQA Spec and the first three conceptual categories of Number and Quantity, Algebra and Functions in the US HS CCSS.

The basic US Modeling cycle of ‘identifying variables, formulating a model, analyzing and performing operations on these relationships to draw conclusions, interpreting the results of the mathematics in terms of the original situation, validating the conclusions, and reporting on the conclusions’ features throughout the OxfordAQA Spec. This is particularly so in Statistics and Mechanics, and would be evidenced with questions set in contexts within the exam papers where choices, assumptions, and approximations would be needed in solving problems.

Geometry is mostly covered in Coordinate Geometry and Transformations in OxfordAQA. The US Statistics and Probability forms a pretty good subset of the material covered in the Statistics sections of the OxfordAQA Spec.

Pure Mathematics (OxfordAQA Spec)

Within the Number and Quantity section of the US HS CCSS there is mention of ‘The Complex Number System’ and ‘Vector and Matrix Quantities’. These topics are encountered in the OxfordAQA Further Mathematics Specification (9665) and do not feature in the A-level Mathematics specification.

One of the major differences between the US HS CCSS and the OxfordAQA Spec is that there is no Calculus in the US Curriculum. The OxfordAQA International GCSE introduces polynomial differentiation and integration which is then built on extensively throughout the Pure Mathematics sections of the OxfordAQA Spec. Calculus is only referenced on page 57 of the US Common Core in relation to extending the Functions conceptual category, ‘a student’s work with functions, for example, crosses a number of traditional course boundaries, potentially up through and including calculus’. Students who have not encountered any calculus may find themselves at a considerable disadvantage if applying to UK universities where familiarity with calculus will be assumed not just in Mathematics degrees but also in Medicine, Engineering, Sciences, and Economics.

Statistics (OxfordAQA Spec)

There are noticeably different approaches to statistics and probability. OxfordAQA uses more technical language and possibly a more theoretical approach whereas US HS CCSS has more emphasis on modelling and inference. As is to be expected, the OxfordAQA Spec goes considerably further that the US HS CCSS. It specifically mentions Bernouilli, Binomial and Poisson distributions whereas no distribution models are named in the US HS CCSS despite examples that feature some of these distributions (see for example the Binomial distribution in HSS-MD.A.3).

Overall, the content is broadly similar for the PSM1 (Pure Maths, Statistics and Mechanics) module. However, the OxfordAQA Unit S2 (Statistics) features continuous random variables including the exponential and normal distributions and a range of hypothesis tests. While the US HS CCSS references a probability distribution for a random variable this only appears to be for discrete data, referenced as categorical or for a sample space. An appreciation of the normal distribution and hypothesis testing would be useful for students pursuing a range of degree courses including medicine, engineering, sciences, economics, and social sciences.

Mechanics (OxfordAQA Spec)

While modelling is a prominent feature within the US HS CCSS there are very few if any applications to mechanics. There is no mention of Newton's laws, and while there is mention of vectors, speed and one mention of acceleration (p58) this is not in the context of kinematics as understood in the OxfordAQA Spec. This is perhaps understandable given the omission of calculus from the US HS CCSS. It is possible or even likely that that these topics may appear in the US Science curriculum but the focus of this guide is on the Mathematics standards.

Detailed comparison of Oxford AQA International AS and A-level Mathematics (9660) Specification (OxfordAQA Spec) with the US High School Common Core State Standards for Mathematics (US HS CCSS)

In considering the tables below please note that where matches have been identified the matches are not necessarily complete. Many matches are complete, but some are only partially complete. In some other cases the matches identified have common elements and may use the same technical language but understood in their contexts they may differ subtly in their interpretation.

International AS Unit P1 (Pure Maths)

P1.1: Algebra

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
1.1.1	Use and manipulation of surds.		No matches for surds in the Common Core
1.1.2	Laws of indices for all rational exponents.	HSN-RN.A.1 HSN-RN.A.2	Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.* Rewrite expressions involving radicals and rational exponents using the properties of exponents.
1.1.3	Quadratic functions and their graphs.	HSA-APR.B.3 HSF-IF.C.8a	Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

			a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
1.1.4	The discriminant of a quadratic function.		No matches for discriminant in the Common Core
1.1.5	Factorisation of quadratic polynomials.	HSA-SSE.B.3a	Factor a quadratic expression to reveal the zeros of the function it defines.
1.1.6	Completing the square.	HSA-SSE.B.3b HSA-REI.B.4a	Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.
1.1.7	Solution of quadratic equations.	HSA-SSE.B.3a HSA-REI.B.4b	Factor a quadratic expression to reveal the zeros of the function it defines. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.
1.1.8	Simultaneous equations, eg one linear and one quadratic, analytical solution by substitution.	HSA-REI.C.5 HSA-REI.C.6 HSA-REI.C.7	Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = –3x$ and the circle $x^2 + y^2 = 3$.

1.1.9	Algebraic manipulation of polynomials, including expanding brackets and collecting like terms.	HSA-APR.D.6	Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.
1.1.10	Simple algebraic division.	HSA-APR.D.6	Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.
1.1.11	Use of the Remainder Theorem and the Factor Theorem.	HSA-APR.B.2	Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).
1.1.12	Application of the Factor Theorem.	HSA-APR.B.2	Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).
1.1.13	Graphs of functions; sketching curves defined by simple equations.	HSF-IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.
1.1.14	Geometrical interpretation of algebraic solution of equations and use of intersection points of graphs of functions to solve equations.	HSF-IF.C.7a	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
1.1.15	Knowledge of the effect of simple transformations on the graph of $y = f(x)$ as represented by $y = a\,f(x)$, $y = f(x) + a$, $y = f(x + a)$, $y = f(ax)$	HSF-BF.B.3	**B. Build new functions from existing functions** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x+ k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and

			illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

P1.2: Coordinate geometry

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
1.2.1	Equation of a straight line, including the forms $y - y_1 = m(x - x_1)$ and $ax + by + c = 0$	HSF-LE.A.2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
1.2.2	Conditions for two straight lines to be parallel or perpendicular to each other.	HSF-LE.A.1	Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
1.2.3	The intersection of a straight line and a curve.	HSA-REI.C.7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = –3x and the circle x2 + y2 = 3.

P1.3: Differentiation

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
1.3.1	The derivative of f (x) as the gradient of the tangent to the graph of y = f (x) at a point; the gradient of the tangent as a limit; interpretation as a rate of change.		Calculus is not included in the US curriculum.
1.3.2	Differentiation of polynomials.		Calculus is not included in the US curriculum.
1.3.3	Differentiation of x n, where n is a rational number, and related sums and differences.		Calculus is not included in the US curriculum.
1.3.4	Applications of differentiation to gradients, tangents and normals, maxima and minima and stationary points, increasing and decreasing functions.		Calculus is not included in the US curriculum.
1.3.5	Second order derivatives		Calculus is not included in the US curriculum.

P1.4: Integration

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
1.4.1	Indefinite integration as the reverse of differentiation.		Calculus is not included in the US curriculum.
1.4.2	Integration of polynomials.		Calculus is not included in the US curriculum.
1.4.3	Integration of xn, where n is a rational number not equal to −1, and related sums and differences.		Calculus is not included in the US curriculum.
1.4.4	Evaluation of definite integrals. Interpretation of the definite integral as the area under a curve.		Calculus is not included in the US curriculum.
1.4.5	Approximation of the area under a curve using the trapezium rule.		Calculus is not included in the US curriculum.

P1.5: Sequences and series

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
1.5.1	Sequences, including those given by a formula for the *n*th term.	HSF-BF.A.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
1.5.2	Sequences generated by a simple relation of the form $x_{n+1} = f(x_n)$	HSF-BF.A.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
1.5.3	Arithmetic series, including the formula for the sum of the first *n* natural numbers.	HSF-BF.A.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
1.5.4	The sum of a finite geometric series.	HSA-SSE.B.4	Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.
1.5.5	The sum to infinity of a convergent ($-1 < r < 1$) geometric series.	HSF-BF.A.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
1.5.6	The binomial expansion of $(1+x)^n$ for positive integer *n*.	HSA-APR.C.5	Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.1

International AS Unit PSM1 (Pure Maths, Statistics and Mechanics)

PP1: Pure Maths

PP1.1: Circle

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
2.1.1.1	The equation of a circle in the form $(x-a)^2+(y-b)^2=r^2$	HSA-REI.C.7 HSG-GPE.A.1	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y=-3x$ and the circle $x^2+y^2=3$. Derive the equation of a circle of given centre and radius using the Pythagorean Theorem; complete the square to find the centre and radius of a circle given by an equation.
2.1.1.2	Translation of circles.	HSG-CO.A.4	Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
2.1.1.3	Coordinate geometry of the circle.	HSG-GPE.B.4	Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centred at the origin and containing the point (0, 2).
2.1.1.4	The equation of the tangent and normal at a given point to a circle.	HSG-C.A.4	Construct a tangent line from a point outside a given circle to the circle.

PP1.2: Trigonometry

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
2.1.2.1	The sine and cosine rules. The area of a triangle in the form $\frac{1}{2}ab\sin C$	HSG-SRT.D.10 HSG-SRT.D.9	Prove the Laws of Sines and Cosines and use them to solve problems. Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.
2.1.2.2	Degree and radian measure.	HSF-TF.A.1	Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.
2.1.2.3	Arc length, area of a sector of a circle.	HSG-C.B.5	Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.
2.1.2.4	Sine, cosine and tangent functions. Their graphs, symmetries and periodicity.	HSF-TF.A.2	Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.
2.1.2.5	Knowledge and use of $\tan\theta = \frac{\sin\theta}{\cos\theta}$; and $sin^2\,\theta + cos^2\,\theta = 1$	HSF-TF.C.8	Prove the Pythagorean identity $sin^2\,\theta + cos^2\,\theta = 1$ and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.
2.1.2.6	Solution of simple trigonometric equations in a given interval of degrees or radians.	HSF-TF.A.3	Use special triangles to determine geometrically the values of sine, cosine, tangent for □/3, □/4 and □/6, and use the unit circle to express the values of sine, cosine, and tangent for □–*x*, □+*x*, and 2□–*x* in terms of their values for *x*, where *x* is any real number.

PP1.3: Exponential and logarithms

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
2.1.3.1	$y = a^x$ and its graph.	HSF-IF.C.8 HSF-IF.C.7	b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y= $(1.02)^t$, y = $(0.97)^t$, y = $(1.01)^{12t}$, y = $(1.2)^{t/10}$, and classify them as representing exponential growth or decay. e. Graph exponential and logarithmic functions, showing intercepts and end behaviour, and trigonometric functions, showing period, midline, and amplitude.
2.1.3.2	Logarithms and the laws of logarithms.	HSF-BF.B.5	Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
2.1.3.3	The solution of equations of the form $a^x = b$ *a x* = *b*	HSF-LE.A.4	For exponential models, express as a logarithm the solution to ab^{ct} = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

S1: Statistics

S1.1: Further probability

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
2.2.1.1	Elementary probability; the concept of a random event and its probability.	HSS-CP.A.1	Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).
2.2.1.2	Addition law of probability. Mutually exclusive events.	HSS-CP.B.7	Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.
2.2.1.3	Multiplication law of probability and conditional probability. Independent events.	HSS-CP.A.2 HSS-CP.A.3 HSS-CP.B.6	Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B. Find the conditional probability of A given B as the fraction of B’s outcomes that also belong to A, and interpret the answer in terms of the model.
2.2.1.4	Application of probability laws.	HSS-CP.B.8	Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.

S1.2: Discrete random variables

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
2.2.2.1	Discrete random variables and their associated probability distributions.	HSS-MD.A.1	(+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.
2.2.2.2	Measures of central tendency and spread.	HSS-ID.A.2	Use statistics appropriate to the shape of the data distribution to compare centre (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
2.2.2.3	Mean, variance and standard deviation for discrete random variables.	HSS-MD.A.2	(+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
2.2.2.4	Mean, variance and standard deviation of a simple function of a discrete random variable.	HSS-MD.A.4	Not explicitly mentioned in US Common Core (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?
2.2.2.5	Mean and variance of the sum or difference of two independent discrete random variables.		Not included in US Common Core
2.2.2.6	Mean and variance of a sum of independent discrete random variables.		Not included in US Common Core

S1.3: Bernoulli and binomial distributions

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
2.2.3.1	Conditions for application of a Bernoulli distribution.		Not included in US Common Core
2.2.3.2	Mean and variance of a Bernoulli.		Not included in US Common Core
2.2.3.3	Binomial distribution.		Not explicitly mentioned in US Common Core
2.2.3.4	Calculation of probabilities using formula and tables.	HSS-MD.A.1	(+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.
2.2.3.5	Mean, variance and standard deviation of a binomial distribution.	HSS-MD.A.3	(+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

3.2.3 M1: Mechanics

M1.1: Motion in a straight line with constant acceleration

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
2.3.1.1	Displacement, speed, velocity, acceleration.	HSN-VM.A.3	(+) Solve problems involving velocity and other quantities that can be represented by vectors.
2.3.1.2	Sketching and interpreting kinematics graphs.	8.EE.B.5	Not explicitly referenced in High School section of the Common Core. The following reference to distance-time graphs is from Grade 8 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.
2.3.1.3	Knowledge and use of constant acceleration equations.		Not included in US Common Core
2.3.1.4	Vertical motion under gravity.		Not included in US Common Core
2.3.1.5	Average speed.		Not included in US Common Core

M1.2: Motion in a straight line with variable acceleration

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
2.3.2.1	Relationship between displacement, velocity and acceleration.	HSN-VM.A.3	(+) Solve problems involving velocity and other quantities that can be represented by vectors.

M1.3: Forces and Newton’s Laws

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
2.3.3.1	Force of gravity.		Not included in US Common Core
2.3.3.2	Tensions in strings and rods, thrusts in rods. Normal Reactions. Resistive forces.		Not included in US Common Core
2.3.3.3	Newton’s three laws of motion.		Not included in US Common Core
2.3.3.4	Connected particle problems.		Not included in US Common Core

M1.4: Momentum and impulse (Restricted to motion in a straight line)

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
2.3.4.1	Concept of momentum.		Not included in US Common Core
2.3.4.2	The principle of conservation of momentum applied to two particles.		Not included in US Common Core
2.3.4.3	Impulse.		Not included in US Common Core
2.3.4.4	Direct impact with a fixed surface.		Not included in US Common Core

International A-level Unit P2 (Pure Maths)

P2.1: Algebra and functions

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.1.1	Definition of a function. Domain and range of a function.	HSF-IF.A.1	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).
3.1.2	Composition of functions.	HSF-BF.A.1c.	(+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.
3.1.3	Inverse functions and their graphs.	HSF-BF.B.4	Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x3 or f(x) = (x+1)/(x–1) for x □ 1. b. (+) Verify by composition that one function is the inverse of another. c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse. d. (+) Produce an invertible function from a non-invertible function by restricting the domain.
3.1.4	The modulus function.	HSA-REI.D.11	Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find

			successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★
3.1.5	Combinations of the transformations on the graph of $y = \mathrm{f}(x)$ as represented by $y = a\mathrm{f}(x)$, $y = \mathrm{f}(x)+a$, $y = \mathrm{f}(x+a)$, $y = \mathrm{f}(ax)$	HSF-BF.B.3	Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x+ k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
3.1.6	Rational functions. Simplification of rational expressions including factorising and cancelling.	HSA-APR.D.6	Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.
3.1.7	Algebraic division.	HSA-APR.D.6	Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.
3.1.8	Partial fractions (denominators not more complicated than repeated linear terms).		Not explicitly mentioned in US Common Core

P2.2: Sequences and series

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.2.1	Binomial series for any rational *n*	HSA-APR.C.5	(+) Know and apply the Binomial Theorem for the expansion of $(x+y)^n$ n powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle
3.2.2	Series expansion of rational functions including the use of partial fractions.		Not explicitly mentioned in US Common Core

P2.3: Coordinate geometry in the (x, y) plane

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.3.1	Cartesian and parametric equations of curves and conversion between the two forms.		Not included in US Common Core

P2.4: Trigonometry

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.4.1	Knowledge of $\sin^{-1}$, $\cos^{-1}$ and $\tan^{-1}$ functions. Understanding of their domains and graphs.	HSF-TF.B.7	(+) Use inverse functions to solve trigonometric equations that arise in modelling contexts; evaluate the solutions using technology, and interpret them in terms of the context.★
3.4.2	Knowledge of secant, cosecant and cotangent. Their relationships to cosine, sine and tangent functions. Understanding of their domains and graphs.		Not explicitly mentioned in US Common Core
3.4.3	Knowledge and use of $1 + \tan^2 x = \sec^2 x$ $1 + \cot^2 x = \operatorname{cosec}^2 x$	HSF-TF.C.8	Prove the Pythagorean identity sin2(θ) + cos2(θ) = 1 and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.
3.4.4	Use of formulae for $\sin(A \pm B)$, $\cos(A \pm B)$ and $\tan(A \pm B)$ and of expressions for $a\cos\theta + b\sin\theta$ in the equivalent forms of $r\cos(\theta \pm \alpha)$ or $r\sin(\theta \pm \alpha)$	HSF-TF.C.9	(+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
3.4.5	Knowledge and use of double angle formulae.		Not explicitly mentioned in US Common Core
3.4.6	Trigonometric identities.		Not explicitly mentioned in US Common Core
3.4.7	Solution of trigonometric equations in a given interval.	HSF-TF.A.3	(+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π –x, π +x, and 2π –x in terms of their values for x, where x is any real number.

P2.5: Exponentials and logarithms

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.5.1	The function e^x and its graph.	HSF-IF.C.7e.	Graph exponential and logarithmic functions, showing intercepts and end behaviour, and trigonometric functions, showing period, midline, and amplitude.
3.5.2	The function In x and its graph; In x as the inverse function of e^x	HSF-IF.C.7e.	Graph exponential and logarithmic functions, showing intercepts and end behaviour, and trigonometric functions, showing period, midline, and amplitude.
3.5.3	Exponential growth and decay.	HSF-IF.C.8b.	Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y= (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.

P2.6: Differentiation

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.6.1	Differentiation of e^x, In x, sin x, cos x, tan x and linear combinations of these functions.		Calculus is not included in the US curriculum.
3.5.2	Differentiation using the product rule, the quotient rule, the chain rule and by the use of $\frac{dy}{dx}=\frac{1}{\frac{dx}{dy}}$		Calculus is not included in the US curriculum.
3.5.3	Differentiation of simple functions defined implicitly or parametrically.		Calculus is not included in the US curriculum.
3.5.4	Equations of tangents and normal for curves specified implicitly.		Calculus is not included in the US curriculum.
3.5.5	Equations of tangents and normal for curves specified in parametric form.		Calculus is not included in the US curriculum.

P2.7: Integration

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.7.1	Integration of e^x, $\frac{1}{x}$, sin x, cos x		Calculus is not included in the US curriculum.
3.7.2	Simple cases of integration: by inspection or substitution;		Calculus is not included in the US curriculum.
3.7.3	by substitution;		Calculus is not included in the US curriculum.
3.7.4	and integration by parts.		Calculus is not included in the US curriculum.
3.7.5	These methods as the reverse processes of the chain and product rules respectively.		Calculus is not included in the US curriculum.
3.7.6	Evaluation of a volume of revolution.		Calculus is not included in the US curriculum.
3.7.7	Simple cases of integration using partial fractions.		Calculus is not included in the US curriculum.

P2.8: Differential equations

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.8.1	Formation of simple differential equations.		Calculus is not included in the US curriculum.
3.8.2	Analytical solution of simple first order differential equations with separable variables.		Calculus is not included in the US curriculum.

P2.9: Numerical methods

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
3.9.1	Location of roots of f $(x) = 0$ by considering changes of sign of f (x) in an interval of x in which f (x) is continuous.		Not included in US Common Core
3.9.2	Approximate solutions of equations using simple iterative methods, including recurrence relations of the form $x_{n+1} = f(x_n)$		Not included in US Common Core
3.9.3	Numerical integration of functions using the mid-ordinate rule and Simpson's Rule.		Not included in US Common Core

P2.10: Vectors

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
3.10.1	Vectors in two and three dimensions.	HSN-VM.A.3	(+) Solve problems involving velocity and other quantities that can be represented by vectors.
3.10.2	Magnitude of a vector.	HSN-VM.A.1	(+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).
3.10.3	Algebraic operations of vector addition and multiplication by scalars, and their geometrical interpretations.	HSN-VM.B.4 HSN-VM.B.5	(+) Add and subtract vectors. a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. c. Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. (+) Multiply a vector by a scalar. a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy). b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v □ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).
3.10.4	Position vectors.	HSN-VM.A.2	(+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
3.10.5	The distance between two points.	HSN-VM.B.4b.	Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
3.10.6	Vector equations of lines.		Not included in US Common Core

3.10.7	The scalar product. Its use for calculating the angle between two lines.		Not included in US Common Core

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International A-level Unit S2 (Statistics)

S2.1: Poisson distribution

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
4.1.1	Conditions for application of a Poisson distribution.		Not included in US Common Core
4.1.2	Poisson distribution as a limiting form of binomial distribution.		Not included in US Common Core
4.1.3	Calculation of probabilities using formula and tables.		Not included in US Common Core
4.1.4	Mean, variance and standard deviation of a Poisson distribution.		Not included in US Common Core
4.1.5	Distribution of sum of independent Poisson random variables.		Not included in US Common Core

S2.2: Continuous random variables

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
4.2.1	Differences from discrete random variables.		Not included in US Common Core
4.2.2	Probability density functions, cumulative distribution functions and their relationship.		Not included in US Common Core
4.2.3	Probability of an observation lying in a specified interval.		Not included in US Common Core
4.2.4	Mean, variance and standard deviation for continuous random variables.		Not included in US Common Core
4.2.5	Mean, variance and standard deviation of a simple function of a continuous random variable.		Not included in US Common Core
4.2.6	Mean and variance of the sum or difference of two independent continuous random variables.		Not included in US Common Core
4.2.7	Mean and variance of a sum of independent continuous random variables.		Not included in US Common Core

S2.3: Exponential distribution

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
4.3.1	Conditions for application of an exponential distribution.		Not included in US Common Core
4.3.2	Calculation of probabilities for an exponential distribution.		Not included in US Common Core
4.3.3	Mean, variance and standard deviation of an exponential distribution.		Not included in US Common Core

S2.4: Normal distribution

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
4.4.1	Properties of normal distributions.		Not included in US Common Core
4.4.2	Calculation of probabilities.		Not included in US Common Core
4.4.3	Mean, variance and standard deviation of a normal distribution.		Not included in US Common Core
4.4.4	Distribution of sum of independent normal random variables.		Not included in US Common Core

S2.5: Estimation

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
4.5.1	Population and sample.		Not included in US Common Core
4.5.2	Unbiased estimators of a population mean and variance.		Not included in US Common Core
4.5.3	Sampling distribution of the mean of a random sample from a normal distribution.		Not included in US Common Core
4.5.4	Normal distribution as an approximation to the sampling distribution of the mean of a large sample from any distribution.		Not included in US Common Core

S2.6: Hypothesis testing

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
4.6.1	Null and alternative hypotheses.		Not included in US Common Core
4.6.2	One-tailed and two-tailed tests, significance level, critical value, critical region, acceptance region, test statistic, p-value, Type I and Type II errors.		Not included in US Common Core
4.6.3	Tests for a population proportion.		Not included in US Common Core
4.6.4	Tests for the mean of a Poisson distribution.		Not included in US Common Core
4.6.5	Tests for the mean of a normal distribution with known variance.		Not included in US Common Core
4.6.6	Tests for the mean of a distribution using a normal approximation.		Not included in US Common Core
4.6.7	Tests for the mean of a normal distribution with unknown variance.		Not included in US Common Core

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International A-level Unit M2 (Mechanics)

M2.1: Mathematical modelling

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
5.1.1	Use of assumptions in simplifying reality.	HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modelling.
5.1.2	Mathematical analysis of models.	HSA-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modelling context.
5.1.3	Interpretation and validity of models.		Not explicitly mentioned in US Common Core

M2.2: Kinematics

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
5.2.1	Relationship between position, velocity and acceleration in one, two or three dimensions, involving variable acceleration.	HSN-VM.A.3	(+) Solve problems involving velocity and other quantities that can be represented by vectors.
5.2.2	Finding position, velocity and acceleration vectors, by the differentiation or integration of $f(t)\mathbf{i} + g(t)\mathbf{j} + h(t)\mathbf{k}$, with respect to t.		Calculus is not included in the US curriculum.

M2.3: Statics and forces

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
5.3.1	Drawing force diagrams, identifying forces present and clearly labelling diagrams.		Not included in US Common Core
5.3.2	Friction, limiting friction, and the relationship F μR		Not included in US Common Core
5.3.3	Modelling forces as vectors, finding the resultant of a number of forces acting at a point.		Not included in US Common Core
5.3.4	Knowledge that the resultant force is zero if a body is in equilibrium.		Not included in US Common Core
5.3.5	Finding the moment of a force about a given point.		Not included in US Common Core
5.3.6	Determining the forces acting on a rigid body when in equilibrium.		Not included in US Common Core
5.3.7	Centres of Mass		Not included in US Common Core
5.3.8	Finding centres of mass by symmetry (eg for circle, rectangle).		Not included in US Common Core
5.3.9	Finding the centre of mass of a system of particles.		Not included in US Common Core
5.3.10	Finding the centre of mass of a composite body.		Not included in US Common Core
5.3.11	Finding the position of a body when suspended from a given point and in equilibrium.		Not included in US Common Core

M2.4: Newton's Law of Motion

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
5.4.1	Applications of Newton's laws to linear motion with constant acceleration.		Not included in US Common Core
5.4.2	Application to situations, with variable acceleration.		Not included in US Common Core

M2.5: Projectiles

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
5.5.1	Motion of a particle under gravity in two dimensions.		Not included in US Common Core
5.5.2	Calculate range, time of flight and maximum height.		Not included in US Common Core
5.5.3	Elimination of time from equations to derive the equation of the trajectory of a projectile.		Not included in US Common Core

M2.6: Work and energy

Ref	OxfordAQA 9660 Maths	Ref	Common Core State Standards
5.6.1	Work done by a constant force.		Not included in US Common Core
5.6.2	Gravitational potential energy.		Not included in US Common Core
5.6.3	Kinetic energy.		Not included in US Common Core
5.6.4	The work-energy principle.		Not included in US Common Core
5.6.5	Conservation of mechanical energy.		Not included in US Common Core
5.6.6	Power, as the rate at which a force does work, and the relationship $P = Fv$		Not included in US Common Core

M2.7: Uniform circular motion

Ref	**OxfordAQA 9660 Maths**	Ref	Common Core State Standards
5.7.1	Motion of a particle in a circle with constant speed.		Not included in US Common Core
5.7.2	Knowledge and use of the relationships $v=r\omega,\ a=r\omega^2$ and $a=\frac{v^2}{r}$		Not included in US Common Core
5.7.3	Angular speed in radians s^{-1} converted from other units such as revolutions per minute or time for one revolution.		Not included in US Common Core
5.7.4	Position, velocity and acceleration vectors in relation to circular motion in terms of **i** and **j**		Not included in US Common Core
5.7.5	Conical pendulum.		Not included in US Common Core