**Mapping guide: Legacy AS and A2 units 7890 to H240**

**1 - Pure Mathematics**

| **OCR Reference.** | **Content Description**  (unshaded content is AS content) | **Legacy Unit and Reference** | **Notes** |
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| **1.01 Proof** | | | |
| **1.01a** | a) Understand and be able to use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion.  *In particular, learners should use methods of proof including proof by deduction and proof by exhaustion.* | Section 5: Specification Content | The 7890 specification explicitly states in section 5, ‘Specification Content’, that ‘candidates are expected to understand the nature of a mathematical proof’, although no explicit mention is made to proof by deduction or proof by exhaustion. |
| **1.01d** | d) Understand and be able to use proof by contradiction.  *In particular, learners should understand a proof of the irrationality of  and the infinity of primes.*  *Questions requiring proof by contradiction will be set on content with which the learner is expected to be familiar e.g. through study of GCSE (9-1), AS or A Level Mathematics.* | Section 5: Specification Content | The 7890 specification explicitly states that: ‘…, candidates are expected to understand the nature of a mathematical proof. In A2 units, questions that require proof by contradiction or disproof by counter-example may be set.’  However, no mention is made in the 7890 specification of the two proofs explicitly stated in the reformed specification. |
| **1.01b** | b) Understand and be able to use the logical connectives .  *Learners should be familiar with the language associated with the logical connectives: “congruence”, “if.....then” and “if and only if” (or “iff”).* | Section 5: Specification Content  Appendix B: Mathematical Notation | The 7890 specification explicitly states that: ‘In all examinations candidates are expected to construct and present clear mathematical arguments, consisting of logical deductions and precise statements involving correct use of symbols and connecting language. In particular, terms such as ‘equals’, ‘identically equals’, ‘therefore’, ‘because’, ‘implies’, ‘is implied by’, ‘necessary’, ‘sufficient’, and notations such as  and  should be understood and used accurately.’  The symbol  is defined in Appendix B of the 7890 specification as ‘is identical to or is congruent to’. Furthermore,  as defined in this Appendix as ‘if *p* then *q*’. The term ‘iff’ is not explicitly mentioned in the 7890 specification; however, the equivalent mathematical symbol appears and is mentioned above. |
| **1.01c** | c) Be able to show disproof by counter example.  *Learners should understand that this means that, given a statement of the form “if P*(*x*) *is true then Q*(*x*) *is true”, finding a single x for which P*(*x*) *is true but Q*(*x*) *is false is to offer a disproof by counter example.*  *Questions requiring proof will be set on content with which the learner is expected to be familiar e.g. through study of GCSE (9-1) or AS Level Mathematics.*  *Learners are expected to understand and be able to use the terms “integer”, “real”, “rational” and “irrational”.* | Section 5: Specification Content  Appendix B: Mathematical Notation  C1 – Indices and Surds (b) & (c) | The 7890 specification explicitly states that: ‘…, candidates are expected to understand the nature of a mathematical proof. In A2 units, questions that require proof by contradiction or disproof by counter-example may be set.’  The notation for the terms ‘integer’, ‘real’ and ‘rational’ can be found in Appendix B of the 7890 specification under Set Notation. The term ‘irrational’ is implicitly covered in C1 in dealing with Indices and Surds. |
| **1.02 Algebra and Functions** | | | |
| **1.02a** | a) Understand and be able to use the laws of indices for all rational exponents.  *Includes negative and zero indices.*  *Problems may involve the application of more than one of the following laws:*    . | C1 – Indices and Surds (a) & (b) | (a) understand rational indices (positive, negative and zero), and use laws of indices in the course of algebraic applications  (b) recognise the equivalence of surd and index notation (e.g. ) |
| **1.02b** | b) Be able to use and manipulate surds, including rationalising the denominator.  *Learners should understand and use the equivalence of surd and index notation.* | C1 – Indices and Surds (a), (b) & (c) | (c) use simple properties of surds such as , including rationalising denominators of the form |
| **1.02c** | c) Be able to solve simultaneous equations in two variables by elimination and by substitution, including one linear and one quadratic equation.  *The equations may contain brackets and/or fractions.*  *e.g.*  *and*  *and* | C1 – Polynomials (e) | (e) solve by substitution a pair of simultaneous equations of which one is linear and one is quadratic |
| **1.02d** | d) Be able to work with quadratic functions and their graphs, and the discriminant (*D* or) of a quadratic function, including the conditions for real and repeated roots.  *i.e. Use the conditions:*  *1.  real distinct roots*  *2.  repeated roots*  *3.  roots are not real*  *to determine the number and nature of the roots of a quadratic equation and relate the results to a graph of the quadratic function.* | C1 – Polynomials (c)  C1 – Coordinate Geometry and Graphs (g) & (h) | Polynomials (c) find the discriminant of a quadratic polynomial  and use the discriminant, e.g. to determine the number of real roots of the equation  Coordinate Geometry and Graphs (g) understand the relationship between a graph and its associated algebraic equation  Coordinate Geometry and Graphs (h) sketch curves with equations of the form *(iii)*  where *a*, *b* and *c* are constants |
| **1.02e** | e) Be able to complete the square of the quadratic polynomial .  *e.g. Writing in the form  in order to find the line of symmetry , the turning point  and to determine the nature of the roots of the equation for example  has no real roots because* . | C1 – Polynomials (b) | (b) carry out the process of completing the square for a quadratic polynomial and use this form, e.g. to locate the vertex of the graph of |
| **1.02f** | f) Be able to solve quadratic equations including quadratic equations in a function of the unknown.  *e.g. ,  or* | C1 – Polynomials (d) & (f) | (d) solve quadratic equations in one unknown  (f) recognise and solve equations in  which are quadratic in some function of  e.g. |
| **1.02g** | g) Be able to solve linear and quadratic inequalities in a single variable and interpret such inequalities graphically, including inequalities with brackets and fractions.  *e.g. , .*  [*Quadratic equations with complex roots are excluded*.] | C1 – Polynomials (d) | (d) solve linear and quadratic inequalities, in one unknown  Solving inequalities with fractions is new content in the reformed specification. |
| **1.02h** | h) Be able to express solutions through correct use of ‘and’ and ‘or’, or through set notation.  *Familiarity is expected with the correct use of set notation for intervals, e.g.*  ,  ,  ,    .  *Familiarity is expected with interval notation, e.g.*  ,  *and* . | Appendix B: Mathematical Notation | Set and interval notation, while stated in Appendix B of the 7890 Specification, has not been examined or used in current examination questions. |
| **1.02i** | i) Be able to represent linear and quadratic inequalities such as  and  graphically. | D1 – Linear Programming (c) | (c) carry out a graphical solution for 2-variable problems  Representing quadratic inequalities graphically is new content in the reformed specification. |
| **1.02j** | j) Be able to manipulate polynomials algebraically.  *Includes expanding brackets, collecting like terms, factorising, simple algebraic division and use of the factor theorem.*  *Learners should be familiar with the terms “quadratic”, “cubic” and “parabola”.*    *Learners should be familiar with the factor theorem as:*  *1.  is a factor of* ;  *2.  is a factor of* .  *They should be able to use the factor theorem to find a linear factor of a polynomial normally of degree*  . *They may also be required to find factors of a polynomial, using any valid method, e.g. by inspection.* | C1 – Polynomials (a)  C2 – Algebra (a) & (b) | Polynomials (a) carry out operations of addition, subtraction, and multiplication of polynomials (including expansion of brackets, collection of like terms and simplifying)  Algebra (a) use the factor theorem  Algebra (b) carry out simple algebraic division (restricted to cases no more complicated than division of a cubic by a linear polynomial)  Note that the remainder theorem, stated in C2 – Algebra (b), is not included in the reformed specification. |
| **1.02k** | k) Be able to simplify rational expressions.  *Includes factorising and cancelling, and algebraic division by linear expressions.*  *e.g. Rational expressions may be of the form*  or .  *Learners should be able to divide a polynomial of degree  by a linear polynomial of the form , identify the quotient and remainder and solve equations of degree .*  *The use of the factor theorem and algebraic division may be required.* | C4 – Algebra and Graphs (a) & (b) | (a) simplify rational expressions, including factorising and cancelling  (b) divide a polynomial, of degree not exceeding 4, by a linear polynomial, and identify the quotient and remainder (which may be zero)  Note that the division by a quadratic polynomial, stated in C4 – Algebra and Graphs (b), is not included in the reformed specification.  The solving of equations of degree  is implicitly covered in C2 – Algebra (a). |
| **1.02l** | l) Understand and be able to use the modulus function, including the notation , and use relations such as  and  in the course of solving equations and inequalities. e.g. solve | C3 – Algebra and Functions (f) | (f) understand the meaning of  and use relations such as  and  in the course of solving equations and inequalities |
| **1.02m** | m) Understand and be able to use graphs of functions.  *The difference between plotting and sketching a curve should be known.* See section 2b. | C1 – Coordinate Geometry and Graphs (g), (h) & (i)  C3 – Algebra and Functions (d), (e), (g) & (i) |  |
| **1.02s** | s) Be able to sketch the graph of the modulus of a linear function involving a single modulus sign.  *i.e. Given the graph of  sketch the graph of* .  [*Graphs of the modulus of other functions are excluded.*] | C3 – Algebra and Functions (g) | (g) understand the relationship between the graphs of  and  Note that the reformed specification only considers graphs of linear functions and not a general . |
| **1.02n** | n) Be able to sketch curves defined by simple equations including polynomials.  *e.g. Familiarity is expected with sketching a polynomial of degree  in factorised form, including repeated roots.*  *Sketches may require the determination of stationary points and, where applicable, distinguishing between them.* | C1 – Coordinate Geometry and Graphs (h)  C1 – Differentiation (d) | Coordinate Geometry and Graphs (h) sketch curves with equations of the form  *(i)* where *n* is a positive or negative integer and *k* is a constant  *(ii)* where *k* is a constant  *(iii)*  where *a*, *b* and *c* are constants  *(iv)* where  is the product of at most 3 linear factors, not necessarily all distinct  Differentiation (d) apply differentiation to…the location of stationary points (the ability to distinguish between maximum points and minimum points is required) |
| **1.02t** | t) Be able to solve graphically simple equations and inequalities involving the modulus function. | C3 – Algebra and Functions (g) | (g) understand the relationship between the graphs of  and |
| **1.02o** | o) Be able to sketch curves defined by  and  (including their vertical and horizontal asymptotes). | C1 – Coordinate Geometry and Graphs (h) | (h) sketch curves with equations of the form  *(i)* where *n* is a positive or negative integer and *k* is a constant |
| **1.02p** | p) Be able to interpret the algebraic solution of equations graphically. | C1 – Coordinate Geometry and Graphs (g) | (g) understand the relationship between a graph and its associated algebraic equation, and interpret geometrically the algebraic solution of equations |
| **1.02q** | q) Be able to use intersection points of graphs to solve equations.  *Intersection points may be between two curves one or more of which may be a polynomial, a trigonometric, an exponential or a reciprocal graph*. | C1 – Coordinate Geometry and Graphs (g) | (g) understand the relationship between a graph and its associated algebraic equation, and interpret geometrically the algebraic solution of equations |
| **1.02r** | r) Understand and be able to use proportional relationships and their graphs.  *i.e. Understand and use different proportional relationships and relate them to linear, reciprocal or other graphs of variation.* | C1 – Coordinate Geometry and Graphs (h) | (h) coordinate Geometry and Graphs: Sketch curves with equations of the form  *(i)* where *n* is a positive or negative integer and *k* is a constant  However, the explicit understanding and use of different proportional relationships is new content. |
| **1.02u** | *Within Stage 1, learners should understand and be able to apply functions and function notation in an informal sense in the context of the factor theorem (1.02j), transformations of graphs (1.02w), differentiation (section 1.07) and the Fundamental Theorem of Calculus (1.08a).* |  |  |
| **1.02u** | u) Understand and be able to use the definition of a function.  *The vocabulary and associated notation is expected*  *i.e. the terms many-one, one-many, one-one, mapping, image, range, domain*.  *Includes knowing that a function is a mapping from the domain to the range such that for each* *x in the domain, there is a unique y in the range with  The range is the set of all possible values of ; learners are expected to use set notation where appropriate.* | C3 – Algebra and Functions (a), (b) & (c) | *(*a) understand the terms function, domain, range and one-one function  The terms many-one, one-many, mapping and image are not explicitly mentioned in the 7890 specification and so are new content.  (b) identify the range of a given function in simple cases  (c) determine whether or not a given function is one-one |
| **1.02v** | v) Understand and be able to use inverse functions and their graphs, and composite functions. Know the condition for the inverse function to exist and be able to find the inverse of a function either graphically, by reflection in the line , or algebraically.  *The vocabulary and associated notation is expected*  *e.g.,,*. | C3 – Algebra and Functions (a), (b), (c) & (d) | (a) understand the terms inverse function and composition of functions  (b) find the composition of two given functions  (c) find the inverse of a one-one function in simple cases  (d) illustrate in graphical terms the relation between a one-one function and its inverse |
| **1.02w** | w) Understand the effect of simple transformations on the graph of  including sketching associated graphs, describing transformations and finding relevant equations: ,*,* and , for any real *a*.  *Only single transformations will be requested.*  *Translations may be specified by a two-dimensional column vector*. | C1 – Coordinate Geometry and Graphs (i) | (i) understand and use the relationships between the graphs of  where *a* is a constant, and express the transformations involved in terms of translations, reflections and stretches |
| **1.02x** | x) Understand the effect of combinations of transformations on the graph of  including sketching associated graphs, describing transformations and finding relevant equations.  *The transformations may be combinations of,* ,  *and , for any real* *a, and any function defined in the Stage 1 or Stage 2 content.* | C3 – Algebra and Functions (e) | (e) use and recognise compositions of transformations of graphs, such as the relationship between the graphs of  and where *a* and *b* are constants |
| **1.02y** | y) Be able to decompose rational functions into partial fractions (denominators not more complicated than squared linear terms and with no more than 3 terms, numerators constant or linear).  *i.e. The denominator is no more complicated than  or  and the numerator is either a constant or linear term.*  *Learners should be able to use partial fractions with the binomial expansion to find the power series for an algebraic fraction or as part of solving an integration problem.* | C4 – Algebra and Graphs (c) | (c) recall an appropriate form for expressing rational functions in partial fractions, and carry out the decomposition, in cases where the denominator is no more complicated than  *(i)*  *(ii)*  and where the degree of the numerator is less than that of the denominator  The reformed specification explicitly states that the numerator will either be constant or linear so differs from the 7890 specification in which the degree of the numerator only has to be less than the denominator. |
| **1.02z** | z) Be able to use functions in modelling.  *Includes consideration of modelling assumptions, limitations and refinements of models, and comparing models.* |  | The explicit consideration of modelling assumptions, limitations and refinements of models (and the comparing of models) is new content. |
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| **1.03 Coordinate Geometry in the *x-y* Plane** | | | |
| **1.03a** | a) Understand and be able to use the equation of a straight line, including the forms ,  and .  *Learners should be able to draw a straight line given its equation and to form the equation given a graph of the line, the gradient and one point on the line, or at least two points on the line.*  *Learners should be able to use straight lines to find:*  *1. the coordinates of the midpoint of a line segment joining two points,*  *2. the distance between two points and*  *3. the point of intersection of two lines.* | C1 – Coordinate Geometry and Graphs (a), (b) and (d) | (a) find the length, gradient and mid-point of a line segment, given the coordinates of its end-points  (b) find the equation of a straight line given sufficient information (e.g. the coordinates of two points on it, or one point on it and its gradient)  (d) interpret and use linear equations, particularly the formsand |
| **1.03b** | b) Be able to use the gradient conditions for two straight lines to be parallel or perpendicular.  *i.e. For parallel lines  and for perpendicular lines .* | C1 – Coordinate Geometry and Graphs (c) | (c) understand and use the relationships between the gradients of parallel and perpendicular lines |
| **1.03c** | c) Be able to use straight line models in a variety of contexts.  *These problems may be presented within realistic contexts including average rates of change.* |  | The explicit consideration of using straight line models in a variety of contexts is new content. |
| **1.03d** | d) Understand and be able to use the coordinate geometry of a circle including using the equation of a circle in the form .  *Learners should be able to draw a circle given its equation or to form the equation given its centre and radius*. | C1 – Coordinate Geometry and Graphs (e) & (f) | (e) understand that the equation  represents the circle with centre  and radius *r*  (f) use algebraic methods to solve problems involving lines and circles  Note that in the reformed specification the use of the expanded form of the circle  is not required. |
| **1.03e** | e) Be able to complete the square to find the centre and radius of a circle. | C1 – Polynomials (b)  C1 – Coordinate Geometry and Graphs (f) | Polynomials (b) carry out the process of completing the square for a quadratic polynomial  Coordinate Geometry and Graphs (f) use algebraic methods to solve problems involving lines and circles |
| **1.03f** | f) Be able to use the following circle properties in the context of problems in coordinate geometry:  1. the angle in a semicircle is a right angle,  2. the perpendicular from the centre of a circle to a chord bisects the chord,  3. the radius of a circle at a given point on its circumference is perpendicular to the tangent to the circle at that point.  *Learners should also be able to investigate whether or not a line and a circle or two circles intersect.* | C1 – Coordinate Geometry and Graphs (f) | (f) knowledge of the following circle properties is included: the angle in a semicircle is a right angle; the perpendicular from the centre to a chord bisects the chord; the perpendicularity of radius and tangent |
| **1.03g** | g) Understand and be able to use the parametric equations of curves and be able to convert between cartesian and parametric forms.  *Learners should understand the meaning of the terms parameter and parametric equation.*  *Includes sketching simple parametric curves.*  *See also section 1.07s.* | C4 – Algebra and Graphs (e) & (f) | (e) understand the use of a pair of parametric equations to define a curve, and use a given parametric representation of a curve in simple cases  (f) convert the equation of a curve between parametric and cartesian forms  The sketching of simple parametric curves is not explicitly mentioned in the 7890 specification and can be seen as new content in the reformed specification. |
| **1.03h** | h) Be able to use parametric equations in modelling in a variety of contexts.  *The contexts may be within pure mathematics or in realistic contexts, for example those involving related rates of change.* |  | The explicit consideration of using parametric equations in a variety of contexts is new content. |
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| **1.04 Sequences and Series** | | | |
| **1.04a** | a) Understand and be able to use the binomial expansion of  for positive integer  and the notations  and ,  or , with .  *e.g. Find the coefficient of theterm in the expansion of*  *Learners should be able to calculate binomial coefficients. They should also know the relationship of the binomial coefficients to Pascal’s triangle and their use in a binomial expansion.*  *They should also know that* . | C2 – Sequences and Series (f) | (f) use the expansion of  where *n* is a positive integer, including the recognition and use of the notations  and *n!* |
| **1.04c** | c) Be able to extend the binomial expansion of  to any rational , including its use for approximation.  *Learners may be asked to find a particular term.*  *The general term will not be required.*  *Learners should be able to write*  *in the form prior to expansion.* | C4 – Algebra and Graphs (d) | (d) use the expansion of  where *n* is a rational number …adapting the standard series to expand, e.g.  is included |
| **1.04b** | b) Understand and know the link to binomial probabilities. | S1 – Discrete Random Variables (b) | (b) use formulae for probabilities for the binomial… distribution |
| **1.04d** | d) Know that the expansion is valid for .  [*The proof is not required.*]  *e.g. Find the coefficient of theterm in the expansion of and state the range of values for which the expansion is valid.* | C4 – Algebra and Graphs (d) | (d) use the expansion of  where *n* is a rational number and |
| **1.04e** | e) Be able to work with sequences including those given by a formula for the  term and those generated by a simple relation of the form .  *Learners may be asked to generate terms, find*  *terms and comment on the mathematical behaviour of the sequence.* | C2 – Sequences and Series (a) | (a) understand the idea of a sequence of terms, and use definitions such as  and relations such as  to calculate successive terms and deduce simple properties |
| **1.04f** | f) Understand the meaning of and work with increasing sequences, decreasing sequences and periodic sequences.  *Learners should know the difference between and be able to recognise:*  *1. a sequence and a series,*  *2. finite and infinite sequences.* | C2 – Sequences and Series (a) |  |
| **1.04g** | g) Understand and be able to use sigma notation for sums of series. | C2 – Sequences and Series (b) | (b) understand and use notation |
| **1.04h** | h) Understand and be able to work with arithmetic sequences and series, including the formulae for the  term and the sum to terms.  *The term arithmetic progression (AP) may also be used.  The first term will usually be denoted by , the last term by  and the common difference by . The sum to  terms will usually be denoted by* . | C2 – Sequences and Series (c) and (d) | (c) recognise arithmetic progressions  (d) use the formulae for the *n*th term and for the sum of the first *n* terms to solve problems involving arithmetic progressions |
| **1.04i** | i) Understand and be able to work with geometric sequences and series including the formulae for the  term and the sum of a finite geometric series.  *Learners should know the difference between convergent and divergent geometric sequences and series.* | C2 – Sequences and Series (c) and (d)  C2 – Algebra (e) | Sequences and Series (c) recognise geometric progressions  Sequences and Series (d) use the formulae for the *n*th term and for the sum of the first *n* terms to solve problems involving geometric progressions  Algebra (e) use logarithms to solve equations of the form  and similar inequalities |
| **1.04j** | j) Understand and be able to work with the sum to infinity of a convergent geometric series, including the use of  and the use of modulus notation in the condition for convergence.  *The term geometric progression (GP) may also be used. The first term will usually be denoted by  and the common ratio by . The sum to terms will usually be denoted by  and the sum to infinity by* . | C2 – Sequences and Series (e) | (e) use the condition  for convergence of a geometric series, and the formula for the sum to infinity of a convergent geometric series |
| **1.04k** | k) Be able to use sequences and series in modelling.  *e.g. Contexts involving compound and simple interest on bank deposits, loans, mortgages, etc. and other contexts in which growth can be modelled by an arithmetic or geometric sequence.*  *Includes solving inequalities involving exponentials and logarithms.* |  | The consideration of using sequences and series in a variety of contexts and in modelling is seen in current C2 examination questions. |
| **1.05 Trigonometry** | | | |
| **1.05a** | a) Understand and be able to use the definitions of sine, cosine and tangent for all arguments. |  | While not explicitly stated in the 7890 specification this is assumed knowledge from GCSE (10.05b). |
| **1.05d** | d) Be able to work with radian measure, including use for arc length and area of sector.  *Learners should know the formulae  and .*  *Learners should be able to use the relationship between degrees and radians.* | C2 – Trigonometry (c) & (d) | (c) understand the definition of a radian, and use the relationship between degrees and radians  (d) use the formulae  and  for the arc length and sector area of a circle  Calculating the arc length of a sector of a circle given its angle and radius is assumed knowledge from GCSE (10.02b). |
| **1.05b** | b) Understand and be able to use the sine and cosine rules.  *Questions may include the use of bearings and require the use of the ambiguous case of the sine rule*. | C2 – Trigonometry (a) | (a) use the sine and cosine rules in the solution of triangles  However, the inclusion of the ambiguous case of the sine rule is new content for the reformed specification (it is currently excluded from the 7890 specification). |
| **1.05c** | c) Understand and be able to use the area of a triangle in the form . | C2 – Trigonometry (b) | (b) use the area formula |
| **1.05e** | e) Understand and be able to use the standard small angle approximations of sine, cosine and tangent:  1.,  2.,  3.,  where  is in radians.  *e.g. Find an approximate expression for  if  is small enough to neglect terms in or above*. |  | The use of the standard small angle approximations for sine, cosine and tangent are new content for the reformed specification. |
| **1.05f** | f) Understand and be able to use the sine, cosine and tangent functions, their graphs, symmetries and periodicities.  *Includes knowing and being able to use exact values of and  for  and multiples thereof and exact values of  for  and multiples thereof.* | C2 – Trigonometry (e) & (g) | (e) relate the periodicity and symmetries of the sine, cosine and tangent functions to the form of their graphs  (g) use the exact values of the sine, cosine and tangent of  The inclusion of the other angles is assumed knowledge from GCSE (10.05c). |
| **1.05g** | g) Know and be able to use exact values of and  for  and multiples thereof, and exact values of for  and multiples thereof. |  | The use of the exact values of sine, cosine and tangent for standard angles expressed in radians is new content. |
| **1.05h** | h) Understand and be able to use the definitions of secant (), cosecant () and cotangent  () and of ,  and  and their relationships to ,  and respectively. | C3 – Trigonometry (b) | (b) understand the relationship of the secant, cosecant and cotangent functions to cosine, sine and tangent  The explicit use of the notation ,  and  is new content in the reformed specification. |
| **1.05i** | i) Understand the graphs of the functions given in 1.05h, their ranges and domains.  *In particular, learners should know that the principal values of the inverse trigonometric relations may be denoted by* arcsin *or* sin− 1*,* arccos *or* cos− 1*,* arctan *or* tan− 1 *and relate their graphs (for the appropriate domain) to the graphs of* sin*,* cos*and* tan*.* | C3 – Trigonometry (a) & (b) | (a) use the notations to denote the principal values of the inverse trigonometric relations, and relate their graphs (for the appropriate domains) to those of sine, cosine and tangent  (b)…use properties and graphs of all six trigonometric functions for angles of any magnitude |
| **1.05j** | j) Understand and be able to use  and .  *In particular, these identities may be used in solving trigonometric equations and simple trigonometric proofs.* | C2 – Trigonometry (f) | (f) use the identities  and |
| **1.05k** | k) Understand and be able to use  and .  *In particular, the identities in 1.05j and 1.05k may be used in solving trigonometric equations, proving trigonometric identities or in evaluating integrals.* | C3 – Trigonometry (c)*(i)* | (c) use trigonometrical identities for the simplification and exact evaluation of expressions, and in the course of solving equations within a specified interval, and select an identity or identities appropriate to the context, showing familiarity in particular with the use of  *(i)*  and |
| **1.05l** | l) Understand and be able to use double angle formulae and the formulae for ,  and .  *Learners may be required to use the formulae to prove trigonometric identities, simplify expressions, evaluate expressions exactly, solve trigonometric equations or find derivatives and integrals.* | C3 – Trigonometry (c)*(ii)* & *(iii)* | (c) use trigonometrical identities for the simplification and exact evaluation of expressions, and in the course of solving equations within a specified interval, and select an identity or identities appropriate to the context, showing familiarity in particular with the use of  *(ii)* the expansions of ,  and  *(iii)* the formulae for ,  and |
| **1.05m** | m) Understand the geometrical proofs of these formulae. |  | The geometrical proofs of the compound angle formulae is new content in the reformed specification. |
| **1.05n** | n) Understand and be able to use expressions for  in the equivalent forms of  or .  *In particular, learners should be able to:*  *1. sketch graphs of* ,  *2. determine features of the graphs including minimum or maximum points and*  *3. solve equations of the form* . | C3 – Trigonometry (c)*(iv)* | (c) use trigonometrical identities for the simplification and exact evaluation of expressions, and in the course of solving equations within a specified interval, and select an identity or identities appropriate to the context, showing familiarity in particular with the use of  *(iv)* the expression of  in the forms  or |
| **1.05o** | o) Be able to solve simple trigonometric equations in a given interval, including quadratic equations in ,  and  and equations involving multiples of the unknown angle.  *e.g.*  for  for  for | C2 – Trigonometry (h) | (h) find all the solutions, within a specified interval, of the equations    and of equations (for example, a quadratic in which are easily reducible to these forms |
| **1.05o** | *Extend their knowledge of trigonometric equations to include radians and the trigonometric identities in Stage 2.* |  |  |
| **1.05p** | p) Be able to construct proofs involving trigonometric functions and identities.  *e.g. Prove that* .  *Includes constructing a mathematical argument as described in section 1.01.* | C3 – Trigonometry (c) |  |
| **1.05q** | q) Be able to use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces.  *Problems may include realistic contexts, e.g. movement of tides, sound waves, etc. as well as problems in vector form which involve resolving directions and quantities in mechanics*. | M1 – Force as a Vector (b) & (c) | (b)…solving problems involving resultants and components of forces  (c) find and use perpendicular components of a force,…  Trigonometric questions on C3 are occasionally set in a realistic context but in general this approach may be seen as new content in the reformed specification. |
| **1.06 Exponentials and Logarithms** | | | |
| **1.06a** | a) Know and use the function *ax* and its graph, where *a* is positive.  Know and use the function e*x* and its graph.  *Examples may include the comparison of two population models or models in a biological or financial context. The link with geometric sequences may also be made.* | C2 – Algebra (c) & (h) | (c) sketch the graph of , where *a > 0,* and understand how different values of *a* affect the shape of the graph  (h) understand the properties of the exponential function  and its graph |
| **1.06b** | b) Know that the gradient of  is equal to  and hence understand why the exponential model is suitable in many applications.  *See 1.07k for explicit differentiation of* . | C3 – Differentiation and Integration (a) | (a) use the derivative of together with constant multiples, sums, and differences |
| **1.06c** | c) Know and use the definition of  (for ) as the inverse of (for all ), where is positive.  *Learners should be able to convert from index to logarithmic form and vice versa as .*  *The values  and  should be known*. | C2 – Algebra (d) | (d) understand the relationship between logarithms and indices |
| **1.06d** | d) Know and use the function  and its graph. | C3 – Algebra and Functions (h) | (h) understand the properties of the logarithmic function  and its graph |
| **1.06e** | e) Know and use  as the inverse function of .  *e.g. In solving equations involving logarithms or exponentials*.  *The values  and  should be known*. | C3 – Algebra and Functions (h) | (h)…including their relationship as inverse functions |
| **1.06f** | f) Understand and be able to use the laws of logarithms:  1.  2.  3.  (including, for example,  and )  *Learners should be able to use these laws in solving equations and simplifying expressions involving logarithms*.  [*Change of base is excluded*.] | C2 – Algebra (d) | (d)…use the laws of logarithms (excluding change of base) |
| **1.06g** | g) Be able to solve equations of the form  for .  *Includes solving equations which can be reduced to this form such as , either by reduction to the form or by taking logarithms of both sides.* | C2 – Algebra (e) | (e) use logarithms to solve equations of the form and similar inequalities |
| **1.06h** | h) Be able to use logarithmic graphs to estimate parameters in relationships of the form  and , given data for  and *.*  *Learners should be able to reduce equations of these forms to a linear form and hence estimate values of  and , or and  by drawing graphs using given experimental data and using appropriate calculator functions.* |  | Using logarithmic graphs is new content in the reformed specification. |
| **1.06i** | i) Understand and be able to use exponential growth and decay and use the exponential function in modelling.  *Examples may include the use of in continuous compound interest, radioactive decay, drug concentration decay and exponential growth as a model for population growth. Includes consideration of limitations and refinements of exponential models.* | C3 – Algebra and Functions (i) | (i) understand exponential growth and decay |
| **1.07 Differentiation** | | | |
| **1.07a** | a) Understand and be able to use the derivative of  as the gradient of the tangent to the graph of  at a general point . | C1 – Differentiation (a) | (a) understand the gradient of a curve at a point as the limit of the gradients of a suitable sequence of chords |
| **1.07b** | b) Understand and be able to use the gradient of the tangent at a point where  as:  1. the limit of the gradient of a chord as  tends to  2. a rate of change of  with respect to *.*  *Learners should be able to use the notation  to denote a rate of change of  with respect to .*  *Learners should be able to use the notations  and  and recognise their equivalence.* | C1 – Differentiation (a) & (b) | (a) understand the gradient of a curve at a point as the limit of the gradients of a suitable sequence of chords  (b) understand the ideas of a derived function and use the notations  and |
| **1.07c** | c) Understand and be able to sketch the gradient function for a given curve. |  | Sketching the gradient function for a given curve is new content in the reformed specification. |
| **1.07d** | d) Understand and be able to find second derivatives.  *Learners should be able to use the notations  and  and recognise their equivalence*. | C1 – Differentiation (b) | (b) understand the ideas of a derived function and second order derivative, and use the notation  and |
| **1.07f** | f) Understand and be able to use the second derivative in connection to convex and concave sections of curves and points of inflection.  *In particular, learners should know that:*  *1. if  on an interval, the function is convex in that interval;*  *2. if  on an interval the function is concave in that interval;*  *3. if  and the curve changes from concave to convex or vice versa there is a point of inflection.* |  | The ideas of convex and concave sections of curve and points of inflection are new content in the reformed specification. |
| **1.07e** | e) Understand and be able to use the second derivative as the rate of change of gradient.  *e.g. For distinguishing between maximum and minimum points*.  *For the application to points of inflection, see 1.07f.* | C1 – Differentiation (d) | (d)…the ability to distinguish between maximum points and minimum points is required |
| **1.07g** | g) Be able to show differentiation from first principles for small positive integer powers of .  *In particular, learners should be able to use the definition  including the notation.*  [*Integer powers greater than 4 are excluded*.] |  | Differentiation from first principles is new content in the reformed specification. |
| **1.07h** | h) Be able to show differentiation from first principles for  and . |  | Differentiation of sine and cosine from first principles is new content in the reformed specification. |
| **1.07i** | i) Be able to differentiate *,* for rational values of *n*, and related constant multiples, sums and differences. | C1 – Differentiation (c) | (c) use the derivative of  (for any rational *n*), together with constant multiplies, sums and differences |
| **1.07j** | j) Be able to differentiate  and , and related sums, differences and constant multiples. | C3 – Differentiation and Integration (a) | (a) use the derivatives of , together with constant multiples, sums and differences  The derivative of  is not explicitly covered in the 7890 specification and can be considered to be new content in the reformed specification. |
| **1.07k** | k) Be able to differentiate , ,  and related sums, differences and constant multiples. | C4 – Differentiation and Integration (a) | (a) use the derivatives of , , , together with sums, differences and constant multiples |
| **1.07l** | l) Understand and be able to use the derivative of . | C3 – Differentiation and Integration (a) | (a) use the derivatives of , together with constant multiples, sums and differences |
| **1.07m** | m) Be able to apply differentiation to find the gradient at a point on a curve and the equations of tangents and normals to a curve. | C1 – Differentiation (d) | (d) apply differentiation to gradients, tangents and normals |
| **1.07p** | p) Be able to apply differentiation to find points of inflection on a curve.  *In particular, learners should know that if a curve has a point of inflection at  then  and there is a sign change in the second derivative on either side of ; if also  at that point, then the point of inflection is a stationary point, but if  at that point, then the point of inflection is not a stationary point.* |  | Applying differentiation to find points of inflection on a curve is new content in the reformed specification. |
| **1.07n** | n) Be able to apply differentiation to find and classify stationary points on a curve as either maxima or minima.  *Classification may involve use of the second derivative or first derivative or other methods.* | C1 – Differentiation (d) | (d) apply differentiation…the location of stationary points |
| **1.07o** | o) Be able to identify where functions are increasing or decreasing.  *i.e. To be able to use the sign of  to determine whether the function is increasing or decreasing.* | C1 – Differentiation (d) | (d) apply differentiation…increasing and decreasing functions |
| **1.07q** | q) Be able to differentiate using the product rule and the quotient rule. | C3 – Differentiation and Integration (c) | (c) differentiate products and quotients |
| **1.07r** | r) Be able to differentiate using the chain rule, including problems involving connected rates of change and inverse functions.  *In particular, learners should be able to use the following relations:*  *and .* | C3 – Differentiation and Integration (b), (d) & (e) | (b) differentiate composite functions using the chain rule  (d) understand and use the relation  (e) apply differentiation to connected rates of change |
| **1.07s** | s) Be able to differentiate simple functions and relations defined implicitly or parametrically for the first derivative only.  *They should be able to find the gradient at a point on a curve and to use this to find the equations of tangents and normals, and to solve associated problems.*  *Includes differentiation of functions defined in terms of a parameter using the chain rule.* | C4 – Differentiation and Integration (b) | (b) find and use the first derivative of a function which is defined parametrically or implicitly |
| **1.07t** | t) Be able to construct simple differential equations in pure mathematics and in context (contexts may include kinematics, population growth and modelling the relationship between price and demand). | C4 – First Order Differential Equations (a) | (a) formulate a simple statement involving a rate of change as a differential equation, including the introduction if necessary of a constant of proportionality |
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| **1.08 Integration** | | | |
| **1.08a** | a) Know and be able to use the fundamental theorem of calculus.  *i.e. Learners should know that integration may be defined as the reverse of differentiation and be able to apply the result that ,*  *for sufficiently well-behaved functions.*  *Includes understanding and being able to use the terms indefinite and definite when applied to integrals*. | C2 – Integration (a) | (a) understand indefinite integration as the reverse process of differentiation |
| **1.08b** | b) Be able to integrate  where  and related sums, differences and constant multiples.    *Learners should also be able to solve problems involving the evaluation of a constant of integration e.g. to find the equation of the curve through  for which* . | C2 – Integration (a) & (b) | (a)…integrate  (for any rational  except -1), together with constant multiples, sums and differences  (b) solve problems involving the evaluation of a constant of integration, e.g. to find the equation of the curve through  for which |
| **1.08c** | c) Be able to integrate , , ,  and related sums, differences and constant multiples.  [*Integrals of ,  and will be given if required.*]  *This includes using trigonometric relations such as double-angle formulae to facilitate the integration of functions such as .* | C3 – Differentiation and Integration (f)  C4 – Differentiation and Integration (c) & (d) | (f) Integrate and , together with constant multiplies, sums, and differences  (c) extend the idea of ‘reverse differentiation’ to include the integration of trigonometric functions  (d) use trigonometric relations (such as double angle formulae) in order to facilitate the integration of functions such as |
| **1.08d** | d) Be able to evaluate definite integrals. | C2 – Integration (c) | (c) evaluate definite integrals |
| **1.08e** | e) Be able to use a definite integral to find the area between a curve and the *x*-axis.  *This area is defined to be that enclosed by a curve, the x-axis and two ordinates. Areas may be included which are partly below and partly above the x-axis, or entirely below the x-axis.* | C2 – Integration (d) | (d) use integration to find the area of a region bounded by a curve and … the coordinate axes… |
| **1.08f** | f) Be able to use a definite integral to find the area between two curves.  *This may include using integration to find the area of a region bounded by a curve and lines parallel to the coordinate axes, or between two curves or between a line and a curve.*  This includes curves defined parametrically. | C2 – Integration (d) | (d) use integration to find the area of a region bounded by a curve and lines parallel to the coordinate axes, or between two curves or between a line and a curve  The inclusion of curves defined parametrically is new content for the reformed specification.  Note that definite integration to find a volume of revolution is not included in the reformed specification. |
| **1.08g** | g) Understand and be able to use integration as the limit of a sum.  *In particular, they should know that the area under a graph can be found as the limit of a sum of areas of rectangles.*  *See also 1.09f.* |  | See later reference in 1.09f |
| **1.08h** | h) Be able to carry out simple cases of integration by substitution.  *Learners should understand the relationship between this method and the chain rule.*  *Learners will be expected to integrate examples in the form , such as  or , either by inspection or substitution.*  *Learners will be expected to recognise an integrand of the form  such as  or* .  *Integration by substitution is limited to cases where one substitution will lead to a function which can be integrated. Substitutions may or may not be given.*  *Learners should be able to find a suitable substitution in integrands such as or* | C3 – Differentiation and Integration (g)  C4 – Differentiation and Integration (f) & (h) | (g) integrate expressions involving a linear substitution  (f) recognise an integrand of the form  (h) use a given substitution to simplify and evaluate either a definite or an indefinite integral (the relationship between integration by substitution and the chain rule should be understood)  The emphasis on learners finding a suitable substitution is new content for the reformed specification. |
| **1.08i** | i) Be able to carry out simple cases of integration by parts.  *Learners should understand the relationship between this method and the product rule.*  *Integration by parts may include more* *than one application of the method e.g. .*  *Learners will be expected to be able to apply integration by parts to the integral of  and related functions.*  [*Reduction formulae are excluded*.] | C4 – Differentiation and Integration (g) | (g) recognise when an integrand can usefully be regarded as a product, and use integration by parts to integrate |
| **1.08j** | j) Be able to integrate functions using partial fractions that have linear terms in the denominator.  *i.e. Functions with denominators no more complicated than the forms  or .* | C4 – Differentiation and Integration (e)  C4 – Algebra and Graphs (c)*(i)* & *(ii)* | Differentiation and Integration (e) integrate rational functions by means of decomposition into partial fractions (restricted to the types of partial fractions specified in Algebra and Graphs (c)*(i)* & *(ii)*)  Algebra and Graphs (c) recall an appropriate form for expressing rational functions in partial fractions, and carry out the decomposition, in cases where the denominator is no more complicated than  *(i)*  *(ii)* ) |
| **1.08k** | k) Be able to evaluate the analytical solution of simple first order differential equations with separable variables, including finding particular solutions.  *Separation of variables may require factorisation involving a common factor.*  *Includes: finding by integration the general solution of a differential equation involving separating variables or direct integration; using a given initial condition to find a particular solution.* | C4 – First Order Differential Equations (b) & (c) | (b) find by integration a general form of solution for a differential equation in which the variables are separable  (c) use an initial condition to find a particular solution of a differential equation |
| **1.08l** | l) Be able to interpret the solution of a differential equation in the context of solving a problem, including identifying limitations of the solution.  *Includes links to differential equations connected with kinematics.*  *e.g. If the solution of a differential equation is , where  is the velocity of a parachutist, describe the motion of the parachutist.* | C4 – First Order Differential Equations (d)  M1 – Kinematics of Motion in a Straight Line (c) | First Order Differential Equations (d) interpret the solution of a differential equation in the context of a problem being modelled by the equation  The explicit identifying of limitations to the solution is new content for the reformed specification.  Kinematics of Motion in a Straight Line (c) use differentiation and integration with respect to time to solve simple problems concerning displacement, velocity and acceleration |
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| **1.09 Numerical Methods** | | | |
| **1.09a** | a) Be able to locate roots of  by considering changes of sign of  in an interval of  on which  is sufficiently well-behaved.  *Includes verifying the level of accuracy of an approximation by considering upper and lower bounds.* | C3 – Numerical Methods (a) | (a) locate approximately a root of an equation, by means of graphical considerations and/or searching for a sign-change |
| **1.09b** | b) Understand how change of sign methods can fail.  *e.g. when the curve*  *touches the x-axis or has a vertical asymptote.* |  | The explicit understanding of how the change of sign methods can fail is new content for the reformed specification. |
| **1.09c** | c) Be able to solve equations approximately using simple iterative methods and be able to draw associated cobweb and staircase diagrams. | C3 – Numerical Methods (b) & (c)  FP2 – Numerical Methods (a) | (b) understand the idea of, and use the notation for, a sequence of approximations which converges to a root of an equation  (c) understand how a given simple iterative formula of the form  relates to the equation being solved, and use a given iteration, or an iteration based on a given rearrangement of an equation, to determine a root to a prescribed degree of accuracy  (a) understand, in geometrical terms involving ‘staircase’ and ‘cobweb’ diagrams  So while currently included in Further Mathematics, ‘cobweb’ and ‘staircase’ diagrams are new content to the reformed A Level specification. |
| **1.09d** | d) Be able to solve equations using the Newton-Raphson method and other recurrence relations of the form . | FP2 – Numerical Methods (d) | (d) derive and use iterations based on the Newton-Raphson method  So while currently included in Further Mathematics, the Newton-Raphson method is new content to the reformed A Level specification. |
| **1.09e** | e) Understand and be able to show how such methods can fail.  *In particular, learners should know that:*  *1. the iteration  converges to a root at  if , and if  is sufficiently close to a;*  *2. the Newton-Raphson method will fail if the initial value coincides with a stationary point.* | FP2 – Numerical Methods (a) & (c) | (a) understand, in geometrical terms involving ‘staircase’ and ‘cobweb’ diagrams, the convergence (or not) of an iteration of the form  to a root of the equation  (c) understand, in geometrical terms, the working of the Newton-Raphson method, and appreciate conditions under which the method may fail to converge to the desired root  So while currently included in Further Mathematics, the convergence (or not) of an iteration of the form  and the Newton-Raphson method is new content to the reformed A Level specification. |
| **1.09f** | f) Understand and be able to use numerical integration of functions, including the use of the trapezium rule, and estimating the approximate area under a curve and the limits that it must lie between.  *Learners will be expected to use the trapezium rule to estimate the area under a curve and to determine whether the trapezium rule gives an under- or over-estimate of the area under a curve*.  *Learners will also be expected to use rectangles to estimate the area under a curve and to establish upper and lower bounds for a given integral. See also 1.08g.*  [*Simpson’s rule is excluded*] | C2 – Integration (e) | (e) use the trapezium rule to estimate the area under a curve, and use sketch graphs, in simple cases, to determine whether the trapezium rule gives an over-estimate or an under-estimate  Note that Simpson’s rule, stated in C3 – Numerical Methods (d), is not included in the reformed specification. |
| **1.09g** | g) Be able to use numerical methods to solve problems in context.  *i.e. for solving problems in context which lead to equations which learners cannot solve analytically.* | C3 – Numerical Methods |  |
| **1.10 Vectors** | | | |
| **1.10a** | a) Be able to use vectors in two dimensions.  *i.e. Learners should be able to use vectors expressed as  or as a column vector , to use vector notation appropriately either as  or .*  *Learners should know the difference between a scalar and a vector, and should distinguish between them carefully when writing by hand.* | C4 – Vectors (a) | (a) use standard notations for vectors |
| **1.10b** | b) Be able to use vectors in three dimensions.  *i.e.* *Learners should be able to use vectors expressed as  or as a column vector .*  *Includes extending 1.10c to 1.10g to include vectors in three dimensions, excluding the direction of a vector in three dimensions.* | C4 – Vectors (a) | (a) use standard notations for vectors |
| **1.10c** | c) Be able to calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form.  *Learners should know that the modulus of a vector is its magnitude and the direction of a vector is given by the angle the vector makes with a horizontal line parallel to the positive x-axis. The direction of a vector will be taken to be in the interval .*  *Includes use of the notation  for the magnitude of  and  for the magnitude of .*  *Learners should be able to calculate the magnitude of a vector  as and its direction by .* | C4 – Vectors (d) | (d) calculate the magnitude of a vector, and identify the magnitude of a displacement vector as being the distance between the points  and  Explicit reference to the direction of a vector is new content for the reformed specification. |
| **1.10d** | d) Be able to add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations.  *i.e. Either a scaling of a single vector or a displacement from one position to another by adding one or more vectors, often in the form of a triangle of vectors*. | C4 – Vectors (b) | (b) carry out addition and subtraction of vectors and multiplication of a vector by a scalar, and interpret these operations in geometrical terms |
| **1.10e** | e) Understand and be able to use position vectors.  *Learners should also understand the meaning of displacement vector, component vector, resultant vector, parallel vector, equal vector and unit vector.* | C4 – Vectors (c) | (c) use unit vectors, position vectors and displacement vectors |
| **1.10f** | f) Be able to calculate the distance between two points represented by position vectors.  *i.e. The distance between the points*  *and*  *is .* | C4 – Vectors (d) | (d) calculate the magnitude of a vector, and identify the magnitude of a displacement vector as being the distance between the points  and |
| **1.10g** | g) Be able to use vectors to solve problems in pure mathematics and in context, including forces. | C4 – Vectors | Using vectors to solve problems in context is new content for the reformed specification. |
| **1.10h** | h) Be able to use vectors to solve problems in kinematics.  *e.g. The equations of uniform acceleration may be used in vector form to find an unknown. See section 3.02e.* |  | Using vectors to solve problems in kinematics is new content for the reformed specification.  Note that: the scalar product; the equation of a straight line; determine whether lines are parallel/intersect/skew; the angle between two lines; and the point of intersection of two lines, are not included in the reformed specification. |

**2 - Statistics**

| **OCR Reference.** | **Content Description**  (unshaded content is AS content) | **Legacy Unit and Reference** | **Notes** |
| --- | --- | --- | --- |
| **2.01 Statistical Sampling** | | | |
| **2.01a** | a) Understand and be able to use the terms ‘population’ and ‘sample’. | S2 – Sampling and Hypothesis Tests (a) | (a) understand the distinction between a sample and a population, and appreciate the benefits of randomness in choosing samples |
| **2.01b** | b) Be able to use samples to make informal inferences about the population. | S2 – Sampling and Hypothesis Tests (a) |  |
| **2.01c** | c) Understand and be able to use sampling techniques, including simple random sampling and opportunity sampling.  *When considering random samples, learners may assume that the population is large enough to sample without replacement unless told otherwise.* | S2 – Sampling and Hypothesis Tests (a) |  |
| **2.01d** | d) Be able to select or critique sampling techniques in the context of solving a statistical problem, including understanding that different samples can lead to different conclusions about the population.  *Learners should be familiar with (and be able to critique in context) the following sampling methods, but will not be required to carry them out: systematic, stratified, cluster and quota sampling.* | S2 – Sampling and Hypothesis Tests (a) & (b) | (b) explain in simple terms why a given sampling method may be unsatisfactory and suggest possible improvements |
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| **2.02 Data Presentation and Interpretation** | | | |
| **2.02a** | a) Be able to interpret tables and diagrams for single-variable data.  *e.g. vertical line charts, dot plots, bar charts, stem-and-leaf diagrams, box-and-whisker plots, cumulative frequency diagrams and histograms (with either equal or unequal class intervals).* | S1 – Representation of Data (a), (b) & (c) | (a) select a suitable way of presenting raw statistical data, and discuss advantages and/or disadvantages that particular representations of data may have  (b) extract from a table or statistical diagram salient features of the data, and express conclusions  (c) construct and interpret stem-and-leaf diagrams, box-and-whisker plots, histograms and cumulative frequency graphs |
| **2.02b** | b) Understand that area in a histogram represents frequency.  *Including* *the link between histograms and probability distributions.*  *Includes understanding, in context, the advantages and disadvantages of different statistical diagrams.* | S1 – Representation of Data (c) |  |
| **2.02c** | c) Be able to interpret scatter diagrams and regression lines for bivariate data, including recognition of scatter diagrams which include distinct sections of the population.  *Learners may be asked to add to diagrams in order to interpret data, but not to draw complete scatter diagrams.*  *[Calculation of equations of regression lines is excluded.]* | S1 – Bivariate Data (f) | (f) understand the concepts of… regression lines in the context of a scatter diagram  Interpreting scatter diagrams for bivariate data is assumed knowledge from GCSE (12.03c & d). |
| **2.02d** | d) Be able to understand informal interpretation of correlation. |  | Interpreting correlation within the context of the variables is assumed knowledge from GCSE (12.03c). |
| **2.02e** | e) Be able to understand that correlation does not imply causation. |  | Appreciating the distinction between correlation and causation is assumed knowledge from GCSE (12.03c). |
| **2.02f** | f) Be able to calculate and interpret measures of central tendency and variation, including mean, median, mode, percentile, quartile, interquartile range, standard deviation and variance.  *Includes understanding that standard deviation is the root mean square deviation from the mean.*  *Includes using the mean and standard deviation to compare distributions.* | S1 – Representation of Data (d) & (e) | (d) understand, use and interpret different measures of central tendency (mean, median, mode) and variation (range, interquartile range, standard deviation)  (e) calculate the mean and standard deviation of a set of data (including grouped data) either from the data itself or from given totals such as *,* |
| **2.02g** | g) Be able to calculate mean and standard deviation from a list of data, from summary statistics or from a frequency distribution, using calculator statistical functions.  *Includes understanding that, in the case of a grouped frequency distribution, the calculated mean and standard deviation are estimates.*  *Learners should understand and be able to use the following formulae for standard deviation:*  *,*  [*Formal estimation of population variance from a sample is excluded. Learners should be aware that there are different naming and symbol conventions for these measures and what the symbols on their calculator represent.*] | S1 – Representation of Data (d) & (e) |  |
| **2.02h** | h) Recognise and be able to interpret possible outliers in data sets and statistical diagrams. |  | A more formal understanding of outliers is new content in the reformed specification.  Recognising outliers on a scatter diagram is assumed knowledge from GCSE (12.03d). |
| **2.02i** | i) Be able to select or critique data presentation techniques in the context of a statistical problem. | S1 – Representation of Data (a) & (b) |  |
| **2.02j** | j) Be able to clean data, including dealing with missing data, errors and outliers.  *Learners should be familiar with definitions of outliers:*  *1. more than 1.5 × (interquartile range) from the nearer quartile*  *2. more than 2 × (standard deviation) away from the mean.* |  | A more formal understanding of outliers (including dealing with errors and missing data) is new content in the reformed specification.  Appreciating there may be errors in data from values (outliers) that do not ‘fit’ is assumed knowledge from GCSE (12.03d). |
| **2.03 Probability** | | | |
| **2.03a** | a) Understand and be able to use mutually exclusive and independent events when calculating probabilities.  *Includes understanding and being able to use the notation:*  , , , .  *Includes linking their knowledge of probability to probability distributions.* | S1 – Probability (f) | (f) understand informally the meaning of exclusive and independent events |
| **2.03b** | b) Be able to use appropriate diagrams to assist in the calculation of probabilities.  *Includes tree diagrams, sample space diagrams, Venn diagrams.* | S1 – Probability (d), (e) & (f) | (d) evaluate probabilities in simple cases by means of enumeration of elementary events  (e) use addition and multiplication of probabilities, as appropriate, in simple cases  (f)… e.g. situations that can be represented by means of a tree diagram  Venn diagrams and sample space diagrams are new content in the reformed specification, but they are assumed knowledge from GCSE (11.02a, b, c & d). |
| **2.03c** | c) Understand and be able to use conditional probability, including the use of tree diagrams, Venn diagrams and two-way tables.  *Includes understanding and being able to use the notations:*  *, , .*  *Includes understanding and being able to use the formulae:*  *,*  *.* | S1 – Probability (f)  S4 – Probability (a), (b) & (c) | (f)…and calculate and use conditional probabilities in simple cases  (a) use the notation  for the probability of the event , and the notations *, ,*  relating to probabilities involving two events  (b) understand and use the result , and extend it to deal with the union of three events  (c) use the result  and the ideas underlying Bayes’ theorem to solve problems involving conditional probability |
| **2.03d** | d) Understand the concept of conditional probability, and calculate it from first principles in given contexts.  *Includes understanding and being able to use the conditional probability formula*  .  [*Use of this formula to find  from  is excluded.*] | S1 – Probability (f)  S4 – Probability (c) |  |
| **2.03e** | e) Be able to model with probability, including critiquing assumptions made and the likely effect of more realistic assumptions. |  | The ability to model with probability and critiquing assumptions is new content in the reformed specification. |
| **2.04 Statistical Distributions** | | | |
| **2.04a** | a) Understand and be able to use simple, finite, discrete probability distributions, defined in the form of a table or a formula such as:  for .  [*Calculation of mean and variance of discrete random variables is excluded*.] | S1 – Discrete Random Variables (a) | (a) construct a probability distribution table relating to a given situation involving a discrete random variable |
| **2.04b** | b) Understand and be able to use the binomial distribution as a model. | S1 – Discrete Random Variables (b) | (b) use formulae for probabilities for the binomial… distribution, and model given situations… as appropriate |
| **2.04d** | d) Know and be able to use the formulae  and  when choosing a particular normal model to use as an approximation to a binomial model. | S1 – Discrete Random Variables (d)  S2 – The Normal Distribution (c) | Discrete Random Variables (d) use formulae for the expectation and variance of the binomial distribution  The Normal Distribution (c) recall conditions under which the normal distribution can be used as an approximation to the binomial distribution, and use this approximation, with a continuity correction, in solving problems |
| **2.04c** | c) Be able to calculate probabilities using the binomial distribution, using appropriate calculator functions.  *Includes understanding and being able to use the formula  and the notation.*  *Learners should understand the conditions for a random variable to have a binomial distribution, be able to identify which of the modelling conditions (assumptions) is/are relevant to a given scenario and be able to explain them in context. They should understand the distinction between conditions and assumptions.* | S1 – Discrete Random Variables (b) & (c) | (b) use formulae for probabilities for the binomial… distribution, and model given situations… as appropriate  (c) use tables of cumulative binomial probabilities (or equivalent calculator functions)  Note that it is expected that calculators available in the assessment will be able to access probabilities from the binomial distribution. |
| **2.04e** | e) Understand and be able to use the normal distribution as a model.  *Includes understanding and being able to use the notation .* | S2 – The Normal Distribution (a) & (b) | (a) understand the use of a normal distribution to model a continuous random variable  (b) solve problems concerning a variable *X*, where |
| **2.04f** | f) Be able to find probabilities using the normal distribution, using appropriate calculator functions.  *This includes finding , for a given normal variable, when  is known.*  *Learners should understand the standard normal distribution, , and the transformation .* | S2 – The Normal Distribution (b) | (b) solve problems concerning a variable *X*, where , including  *(i)* finding the value of , or a related probability, given the values of , *, ,*  *(ii)* finding a relationship between , and  given the value of or a related probability  Note that it is expected that calculators available in the assessment will be able to access probabilities from the normal distribution. |
| **2.04g** | g) Understand links to histograms, mean and standard deviation.  *Learners should know and be able to use the facts that in a normal distribution,*  *1. about two-thirds of values lie in the range ,*  *2. about 95% of values lie in the range ,*  *3. almost all values lie in the range  and*  *4. the points of inflection in a normal curve occur at .*  [*The equation of the normal curve is excluded.*] |  | Links to histograms, mean and standard deviation is new content in the reformed specification. |
| **2.04h** | h) Be able to select an appropriate probability distribution for a context, with appropriate reasoning, including recognising when the binomial or normal model may not be appropriate.  *Includes understanding that a given binomial distribution with large  can be approximated by a normal distribution.*  [*Question*s *explicitly requiring calculations using the normal approximation to the binomial distribution are excluded.*] | S2 - The Normal Distribution (c) | (c) recall conditions under which the normal distribution can be used as an approximation to the binomial distribution, and use this approximation, with a continuity correction, in solving problems |
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| **2.05 Statistical Hypothesis Testing** | | | |
| **2.05a** | a) Understand and be able to use the language of statistical hypothesis testing, developed through a binomial model: null hypothesis, alternative hypothesis, significance level, test statistic, 1-tail test, 2-tail test, critical value, critical region, acceptance region, *p*-value.  *Hypotheses should be stated in terms of parameter values (where relevant) and the meanings of symbols should be stated. For example,*  *“,, whereis the population proportion in favour of the resolution”.*  *Conclusions should be stated in such a way as to reflect the fact that they are not certain. For example,*  *"There is evidence at the 5% level to reject . It is likely that the mean mass is less than 500 g."*  *"There is no evidence at the 2% level to reject . There is no reason to suppose that the mean journey time has changed."*  *Some examples of incorrect conclusion are as follows:*  *"is rejected. Waiting times have increased."*  *"Accept . Plants in this area have the same height as plants in other areas."* | S2 – Sampling and Hypothesis Tests (g) & (h) | (g) understand the nature of a hypothesis test, the difference between one-tail and two-tail tests, and the terms ‘null hypothesis’, ‘alternative hypothesis’, ‘significance level’, ‘rejection region (or critical region)’, ‘acceptance region’ and ‘test statistic’  (h) formulate hypotheses and carry out a hypothesis test of a population proportion in the context of a single observation from a binomial distribution, using direct evaluation of binomial probabilities |
| **2.05b** | b) Be able to conduct a statistical hypothesis test for the proportion in the binomial distribution and interpret the results in context. | S2 – Sampling and Hypothesis Tests (h) |  |
| **2.05c** | c) 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.  *Learners should be able to use a calculator to find critical values.*  *Includes understanding that, where the significance level of a test is specified, the probability of the test statistic being in the rejection region will always be less than or equal to this level.*  [*The use of normal approximation is excluded*.] | S2 – Sampling and Hypothesis Tests (h) |  |
| **2.05d** | d) Recognise that a sample mean,, can be regarded as a random variable.  *Learners should know and be able to use the result that if  then .*  [*The proof is excluded.*] | S2 – Sampling and Hypothesis Tests (c) & (d) | (c) recognise that a sample mean can be regarded as a random variable, and use the facts that  and that  (d) use the fact that  has a normal distribution if  has a normal distribution |
| **2.05e** | e) Be able to conduct a statistical hypothesis test for the mean of a normal distribution with known, given or assumed variance and interpret the results in context.  *Learners should be able to use a calculator to find critical values, but standard tables of the percentage points will be provided in the assessment.*  [*Test for the mean of a non-normal distribution is excluded.*]  [*Estimation of population parameters from a sample is excluded.*] | S2 – Sampling and Hypothesis Tests (i) | (i) formulate hypotheses and carry out a hypothesis test of a population mean following  *(i)* a sample drawn from a normal distribution of known variance |
| **2.05f** | f) Understand Pearson's product-moment correlation coefficient as a measure of how close data points lie to a straight line. | S1 – Bivariate Data (c) | (c) interpret the value of a product moment correlation coefficient in relation to the appearance of a scatter diagram, with particular reference to values close to -1, 0, 1 |
| **2.05g** | g) Use and be able to interpret Pearson's product-moment correlation coefficient in hypothesis tests, using either a given critical value or a *p-*value and a table of critical values.  *When using Pearson's coefficient in an hypothesis test, the data may be assumed to come from a bivariate normal distribution.*  *A table of critical values of Pearson's coefficient will be provided.*  [*Calculation of correlation coefficients is excluded.*] |  | The use of Pearson’s product-moment correlation coefficient in hypothesis tests is new content in the reformed specification. |

**3 – Mechanics**

| **OCR Reference.** | **Content Description**  (unshaded content is AS content) | **Legacy Unit and Reference** | **Notes** |
| --- | --- | --- | --- |
| **3.01 Quantities and Units in Mechanics** | | | |
| **3.01a** | a) Understand and be able to use the fundamental quantities and units in the S.I. system: length (in metres), time (in seconds), mass (in kilograms).  *Learners should understand that these three base quantities are mutually independent.* |  | Understanding the fundamental quantities and units in the S.I. system is assumed knowledge from GCSE (10.01a). |
| **3.01b** | b) Understand and be able to use derived quantities and units: velocity (m/s or ms-1), acceleration (m/s2 or ms-2), force (N), weight (N).  *Learners should be able to add the appropriate unit to a given quantity.* | M1 – Kinematics of Motion in a Straight Line (a)  M1 – Force as a Vector (a)  M1 – Equilibrium of a Particle (a) | Kinematics of Motion in a Straight Line (a) understand the concepts of …velocity and acceleration as vector quantities  Force as a Vector (a) understand the vector nature of force  Equilibrium of a Particle (a)…use the relationship between mass and weight |
| **3.01c** | c) Understand and be able to use the unit for moment (N m). | M2 – Equilibrium of a Rigid Body (a) | (a) calculate the moment of a force about a point in two dimensional situations only |
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| **3.02 Kinematics** | | | |
| **3.02a** | a) Understand and be able to use the language of kinematics: position, displacement, distance, distance travelled, velocity, speed, acceleration, equation of motion.  *Learners should understand the vector nature of displacement, velocity and acceleration and the scalar nature of distance travelled and speed.* | M1 – Kinematics of Motion in a Straight Line (a) | (a) understand the concepts of distance and speed as scalar quantities, and of displacement, velocity and acceleration as vector quantities |
| **3.02b** | b) Understand, use and interpret graphs in kinematics for motion in a straight line. | M1 – Kinematics of Motion in a Straight Line (b) | (b) sketch and interpret (*t*, *x*) and (*t,* *v*) graphs |
| **3.02c** | c) Be able to interpret displacement-time and velocity-time graphs, and in particular understand and be able to use the facts that the gradient of a displacement-time graph represents the velocity, the gradient of a velocity-time graph represents the acceleration, and the area between the graph and the time axis for a velocity-time graph represents the displacement. | M1 – Kinematics of Motion in a Straight Line (b) | (b) sketch and interpret (*t*, *x*) and (*t,* *v*) graphs, and in particular understand and use the facts that  *(i)* the area under a (*t*, *v*) graph represents displacement  *(ii)* the gradient of a (*t*, *x*) graph represents velocity  *(iii)* the gradient of a (*t*, *v*) graph represents acceleration |
| **3.02d** | d) Understand, use and derive the formulae for constant acceleration for motion in a straight line:            *Learners may be required to derive the constant acceleration formulae using a variety of techniques:*  *1. by integration, e.g. ,*  *2. by using and interpreting appropriate graphs, e.g. velocity against time,*  *3. by substitution of one (given) formula into another (given) formula, e.g. substituting  into  to obtain* . | M1 – Kinematics of Motion in a Straight Line (d) | (d) use appropriate formulae for motion with constant acceleration |
| **3.02e** | e) Be able to extend the constant acceleration formulae to motion in two dimensions using vectors:          *Questions set involving vectors may involve either column vector notation, e.g.*  *or* ,  *notation, e.g.* .  [T*he formula  is excluded.*] |  | Extending the constant acceleration formulae to motion in two dimensions using vectors is new content in the reformed specification. |
| **3.02f** | f) Be able to use differentiation and integration with respect to time in one dimension to solve simple problems concerning the displacement, velocity and acceleration of a particle:      and | M1 – Kinematics of Motion in a Straight Line (c) | (c) use differentiation and integration with respect to time to solve simple problems concerning displacement, velocity and acceleration |
| **3.02g** | g) Be able to extend the application of differentiation and integration to two dimensions using vectors:        and  *Questions set may involve either column vector or ,  notation*. |  | Extending the application of differentiation and integration in two dimensions using vectors is new content in the reformed specification. |
| **3.02h** | h) Be able to model motion under gravity in a vertical plane using vectors where  or . |  | Extending the model motion under gravity in a vertical plane using vectors is new content in the reformed specification. |
| **3.02i** | i) Be able to model the motion of a projectile as a particle moving with constant acceleration and understand the limitation of this model.  *Includes being able to:*  *1.Use horizontal and vertical equations of motion to solve problems on the motion of projectiles.*  *2. Find the magnitude and direction of the velocity at a given time or position.*  *3. Find the range on a horizontal plane and the greatest height achieved.*  *4. Derive and use the Cartesian equation of the trajectory of a projectile.*  [*Projectiles on an inclined plane and problems with resistive forces are excluded.*] | M2 – Motion of a Projectile (a), (b) & (c) | (a) model the motion of a projectile as a particle moving with constant acceleration and understand any limitations of this model  (b) use horizontal and vertical equations of motion to solve problems on the motion of projectiles, including finding the magnitude and direction of the velocity at a given time or position, the range on a horizontal plane and the greatest height reached  (c) derive and use the cartesian equation of the trajectory of a projectile, including problems in which the initial speed and/or angle of projection may be unknown |
| **3.03 Forces and Newton’s Laws** | | | |
| **3.03a** | a) Understand the concept and vector nature of a force.  *A force has both a magnitude and direction and can cause an object with a given mass to change its velocity*.  *Includes using directed line segments to represent forces (acting in at most two dimensions).*  *Learners should be able to identify the forces acting on a system and represent them in a force diagram.* | M1 – Force as a Vector (a) | (a) understand the vector nature of force, and use directed line segments to represent forces (acting at most two dimensions) |
| **3.03b** | b) Understand and be able to use Newton’s first law.  *A particle that is at rest (or moving with constant velocity) will remain at rest (or moving with constant velocity) until acted upon by an external force*.  *Learners should be able to complete a diagram with the force(s) required for a given body to remain in equilibrium.* | M1 – Newton’s Law of Motion (a) | (a) apply Newton’s laws of motion to the linear motion of bodies of constant mass moving under the action of constant forces |
| **3.03c** | c) Understand and be able to use Newton’s second law () for motion in a straight line for bodies of constant mass moving under the action of constant forces.  *e.g. A car moving along a road, a passenger riding in a lift or a crane lifting a weight.*  *For Stage 1 learners, examples can be restricted to problems in which the forces acting on the body will be collinear, in two perpendicular directions or given as 2-D vectors.* | M1 – Newton’s Law of Motion (a) & (b) | (b) model, in suitable circumstances, the motion of a body moving vertically  The introduction of the force given as 2D vectors is new content in the reformed specification. |
| **3.03e** | e) Be able to extend use of Newton’s second law to situations where forces need to be resolved (restricted to two dimensions).  *e.g. A force acting downwards on a body at a given angle to the horizontal or the motion of a body projected down a line of greatest slope of an inclined plane.* | M1 – Newton’s Law of Motion (b) | (b)…or on an inclined plane |
| **3.03d** | d) Understand and be able to use Newton’s second law () in simple cases of forces given as two dimensional vectors.  *e.g. Find in vector form the force acting on a body of mass 2 kg when it is accelerating at ms-2*.  *Questions set involving vectors may involve either column vector notation*  *or* ,  *notation .* |  | Newton’s second law given as two dimensional vectors is new content in the reformed specification. |
| **3.03f** | f) Understand and be able to use the weight () of a body to model the motion in a straight line under gravity.  *e.g. A ball falling through the air.* | M1 – Equilibrium of a Particle (a) | (a) identify the forces acting in a given situation, and use the relationship between mass and weight |
| **3.03g** | g) Understand the gravitational acceleration, *g*, and its value in S.I. units to varying degrees of accuracy.  *The value of g may be assumed to take a constant value of 9.8 ms-2 but learners should be aware that g is not a universal constant but depends on location in the universe.*  [*The inverse square law for gravitation is not required.*] |  | An understanding that *g* is not a universal constant is new content in the reformed specification. |
| **3.03h** | h) Understand and be able to use Newton’s third law.  *Every action has an equal and opposite reaction.*  *Learners should understand and be able to use the concept that a system in which none of its components have any relative motion may be modelled as a single particle.* | M1 – Equilibrium of a Particle (e) | (e) use Newton’s third law |
| **3.03l** | l) Be able to extend use of Newton’s third law to situations where forces need to be resolved (restricted to two dimensions). | M1 – Equilibrium of a Particle (e) | (e) use Newton’s third law |
| **3.03i** | i) Understand and be able to use the concept of a normal reaction force.  *Learners should understand and use the result that when an object is resting on a horizontal surface the normal reaction force is equal and opposite to the weight of the object. This includes knowing that when  contact is lost.* | M1 – Equilibrium of a Particle (d) | (d) represent the contact force…the ‘normal force’ |
| **3.03j** | j) Be able to use the model of a ‘smooth’ contact and understand the limitations of the model. | M1 – Equilibrium of a Particle (c) | (c) use the model of a ‘smooth’ contact and understand the limitations of the model |
| **3.03k** | k) Be able to use the concept of equilibrium together with one dimensional motion in a straight line to solve problems that involve connected particles and smooth pulleys.  *e.g. A train engine pulling a train carriage(s) along a straight horizontal track or the vertical motion of two particles, connected by a light inextensible string passing over a fixed smooth peg or light pulley*. | M1 – Newton’s Laws of Motion (a) & (c) | (a) apply Newton’s laws of motion to the linear motion of bodies of constant mass moving under the action of constant forces, for example, a car pulling a caravan  (c) solve simple problems which may be modelled as the motion of two particles, connected by a light inextensible string which may pass over a fixed smooth peg or light pulley |
| **3.03m** | m) Be able to use the principle that a particle is in equilibrium if and only if the sum of the resolved parts in a given direction is zero.  *Problems may involve the resolving of forces, including cases where it is sensible to: 1. resolve horizontally and vertically,*  *2. resolve parallel and perpendicular to an inclined plane,*  *3. resolve in directions to be chosen by the learner, or*  *4. use a polygon of forces.* | M1 – Equilibrium of a Particle (b) | (b) understand and use the principle that a particle is in equilibrium if and only if the vector sum of the forces acting is zero, or equivalently if and only if the sum of the resolved parts in any given direction is zero |
| **3.03n** | n) Be able to solve problems involving simple cases of equilibrium of forces on a particle in two dimensions using vectors, including connected particles and smooth pulleys.  *e.g. Finding the required force*  *for a particle to remain in equilibrium when under the action of forces , ,…*  *For Stage 1 learners, examples can be restricted to problems in which the forces acting on the body will be collinear, in two perpendicular directions or given as 2-D vectors.* |  | The case of equilibrium of forces on a particle in two dimensions using vectors is new content in the reformed specification. |
| **3.03o** | o) Be able to resolve forces for more advanced problems involving connected particles and smooth pulleys.  *e.g. The motion of two particles, connected by a light inextensible string passing over a light pulley placed at the top of an inclined plane*. | M1 – Newton’s Laws of Motion (b) | (b) model, in suitable circumstances, the motion of a body moving vertically or on an inclined plane, as motion with constant acceleration and understand any limitations of this model |
| **3.03p** | p) Understand the term ‘resultant’ as applied to two or more forces acting at a point and use vector addition in solving problems involving resultants and components of forces.  *Includes understanding that the velocity vector gives the direction of motion and the acceleration vector gives the direction of resultant force.*  *Includes being able to find and use perpendicular components of a force, for example to find the resultant of a system of forces or to calculate the magnitude and direction of a force.*  [*Solutions should involve calculation, not scale drawing.*] | M1 – Force as a Vector (b) & (c) | (b) understand the term ‘resultant’ as applied to two or more forces acting at a point, and use vector addition in solving problems involving resultants and components of forces  (c) find and use perpendicular components of a force, e.g. in finding the resultant of a system of forces, or to calculate the magnitude and direction of a force |
| **3.03q** | q) Be able to solve problems involving the dynamics of motion for a particle moving in a plane under the action of a force or forces.  *e.g. At time s the force acting on a particle* P *of mass* *kg is* N. P *is initially at rest at the point with position vector* . *Find the position vector of* P *when* *s*. | M1 – Newton’s Laws of Motion (a) & (b) | Problems set that involve the use of vectors is new content in the reformed specification. |
| **3.03r** | r) Understand the concept of a frictional force and be able to apply it in contexts where the force is given in vector or component form, or the magnitude and direction of the force are given. | M1 – Equilibrium of a Particle (d) | (d) represent the contact force between two rough surfaces by two components, the ‘normal force’ and the ‘frictional force’ |
| **3.03s** | s) Be able to represent the contact force between two rough surfaces by two components (the ‘normal’ contact force and the ‘frictional’ contact force).  *Questions set will explicitly use the terms normal (contact) force, frictional (contact) force and magnitude of the contact force*. | M1 - Equilibrium of a Particle (d) | (d) represent the contact force between two rough surfaces by two components, the ‘normal force’ and the ‘frictional force’ |
| **3.03t** | t) Understand and be able to use the coefficient of friction and the  model of friction in one and two dimensions, including the concept of limiting friction.  [*Knowledge of the angle of friction is excluded.*] | M1 - Equilibrium of a Particle (d) | (d) …understand the concept of limiting friction, recall the definition of coefficient of friction, and use the relationship  or  as appropriate |
| **3.03u** | u) Understand and be able to solve problems regarding the static equilibrium of a body on a rough surface and solve problems regarding limiting equilibrium. | M1 - Equilibrium of a Particle (d) | (d) …understand the concept of …limiting equilibrium |
| **3.03v** | v) Understand and be able to solve problems regarding the motion of a body on a rough surface.  *e.g. The motion of a body projected down a line of greatest slope on a rough inclined plane*.  [*Problems set on inclined planes will only consider motion along the line of greatest slope and therefore a vector consideration of the motion will not be required.*] | M1 – Newton’s Laws of Motion (b) |  |
| **3.04 Moments** | | | |
| **3.04a** | a) Be able to calculate the moment of a force about an axis through a point in the plane of the body.  *For coplanar forces, moments may be described as being about a point.*  [*Understanding of the vector nature of moments is excluded.*] | M2 – Equilibrium of a Rigid Body (a) | (a) calculate the moment of a force about a point in two dimensional situations only |
| **3.04b** | b) Understand that when a rigid body is in equilibrium the resultant moment is zero and the resultant force is zero. | M2 – Equilibrium of a Rigid Body (b) | (b) use the principle that, under the action of coplanar forces, a rigid body is in equilibrium if and only if *(i)* the vector sum of the forces is zero, and *(ii)* the sum of the moments of the forces about any point is zero |
| **3.04c** | c) Be able to use moments in simple static contexts.  *e.g. To determine the forces acting on a horizontal beam or to determine the forces acting on a ladder resting on horizontal ground against a vertical wall.*  *Questions will be set in which the context of the problem can be modelled using rectangular laminas, uniform and non-uniform rods only*.  *Learners may assume that:*  *1. for a uniform rod the weight acts at the midpoint of the rod,*  *2. for a non-uniform rod the weight acts at either a specified given point or is to be determined by moments,*  *3. for a rectangular lamina the weight acts at its point of symmetry*. | M2 – Equilibrium of a Rigid Body (c) | (c) solve problems involving the equilibrium of a single rigid body under the action of coplanar forces |

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| **Content from Legacy Units (C1, C2, C3, C4, S1, M1) which does not appear in the reformed A level specification (H240):**  C1 - Coordinate Geometry and Graphs (f): The use of the equation of a circle in expanded form  C2 – Algebra (a): use the remainder theorem  C3 – Algebra and Functions (g) understand the relationship between the graphs of  and  - only the graph of the modulus of a linear function appears in the reformed specification and not a general  C3 – Differentiation and Integration (h): use definite integration to find a volume of revolution about one of the coordinate axes  C3 – Numerical Methods (d): carry out numerical integration of functions by means of Simpson’s rule  C4 – Algebra and Graphs (b): divide a polynomial, of degree not exceeding 4, by a … quadratic polynomial, and identify the quotient and remainder  C4 – Vectors (e): calculate the scalar product of two vectors (in either two or three dimensions), and use the scalar product to determine the angle between two directions and to solve problems concerning perpendicularity of vectors  C4 – Vectors (f): understand the significance of all the symbols used when the equation of a straight line is expressed in the form  C4 – Vectors (g): determine whether two lines are parallel, intersect or are skew  C4 – Vectors (h): find the angle between two lines, and the point of intersection of two lines when it exists  M1 – Linear Momentum (a): recall and use the definition of linear momentum and show understanding of its vector nature (in one dimension only)  M1 – Linear Momentum (b): understand and use conservation of linear momentum in simple applications involving the direct collision of two bodies moving in the same straight line before and after impact, including the case where the bodies coalesce  S1 – Probability (a): understand the terms permutation and combination  S1 – Probability (b): solve problems about selections  S1 – Probability (c): solve problems about arrangements of objects in a line, including those involving *(i)* repetition, *(ii)* restriction  S1 – Probability (d): evaluate probabilities in simple cases by … calculation using permutations and combinations  S1 – Discrete Random Variables (a): … and calculate the expectation, variance and standard deviation of a discrete random variable  S1 – Discrete Random Variables (b): use formulae for probabilities for the … geometric distribution, and model given situations… as appropriate  S1 – Discrete Random Variables (d): use formulae for … the expectation of the geometric distribution  S1 – Bivariate Data (a): calculate, both from simple raw data and from summarised data, the product moment correlation coefficient for a set of bivariate data  S1 – Bivariate Data (b): understand the basis of Spearman’s coefficient of rank correlation, and calculate its value  S1 – Bivariate Data (d): understand that the value of a correlation coefficient is unaffected by linear transformations (coding) of the variables  S1 – Bivariate Data (e): understand the difference between an independent (or controlled) variable and a dependent variable  S1 – Bivariate Data (f): understand the concepts of least squares regression lines… in the context of a scatter diagram  S1 – Bivariate Data (g): calculate, both from simple raw data and from summarised data, the equation of a regression line, understand the distinction between the regression line of *y* on *x* and that of *x* on *y*, and use the fact that both regression lines pass through the mean centre  S1 – Bivariate Data (h): select and use, in the context of a problem, the appropriate regression line to estimate a value, and be able to interpret in context the uncertainties of such estimations |

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