# Mapping guide: Legacy AS units 3890 to H230

## 1 - Pure Mathematics

| **OCR Reference.** | **Content Description** | **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. |

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| **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 ContentAppendix 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 ContentAppendix B: Mathematical NotationC1 – 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 equationCoordinate 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 problemsRepresenting 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. |
| **1.02m** | 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) |  |
| **1.02n** | 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 distinctDifferentiation (d) apply differentiation to…the location of stationary points (the ability to distinguish between maximum points and minimum points is required) |
| **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) 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).* |  |  |
| **1.02w** | 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 |
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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 circlesNote 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  |
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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!*  |
| **1.04b** | b) Understand and know the link to binomial probabilities.  | S1 – Discrete Random Variables (b) | (b) use formulae for probabilities for the binomial… distribution |
| **1.05 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). |
| **1.05b** | 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   |
| **1.05f** | 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). |
| **1.05j** | 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   |
| **1.05o** | 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 |
| **1.06 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  |
| **1.07e** | 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. |
| **1.07i** | 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 |
| **1.07m** | 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 |
| **1.07n** | 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 |
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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  |
| **1.08d** | 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 lines parallel to the coordinate axes, or between two curves or between a line and a curveNote that the reformed specification only considers the area between a curve and the *x*-axis, which is a significant reduction on the current C2 – Integration (d) content. |
| **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 |
| **1.10c** | 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  andExplicit 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. |  | Using vectors to solve problems in context is new content for the reformed specification. |

## 2 - Statistics

| **OCR Reference.** | **Content Description** | **Legacy Unit and Reference** | **Notes** |
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| **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 diagramInterpreting 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). |
| **2.04 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 |
| **2.04c** | 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. |
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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) |  |

## 3 – Mechanics

| **OCR Reference.** | **Content Description** | **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 quantitiesForce as a Vector (a) understand the vector nature of forceEquilibrium of a Particle (a)…use the relationship between mass and weight  |
| **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 |
| **3.02f** | 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 |
| **3.03 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 verticallyThe introduction of the force given as 2D vectors is new content in the reformed specification. |
| **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 |
| **3.03i** | 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  |
| **3.03n** | 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. |
| **3.03r** | 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’ |

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| **Content from Legacy Units (C1, C2, S1, M1) which does not appear in the reformed AS level specification (H230):**C1 - Coordinate Geometry and Graphs (f): The use of the equation of a circle in expanded form  C2 – Trigonometry (c): understand the definition of a radian, and use the relationship between degrees and radiansC2 – Trigonometry (d): use the formulae  and  for the arc length and sector area of a circleC2 – Sequences and Series (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 propertiesC2 – Sequences and Series (b): understand and use notationC2 – Sequences and Series (c): recognise arithmetic and geometric progressionsC2 – 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 arithmetic or geometric progressions (including the formula  for the sum of the first *n* natural numbers)C2 – Sequences and Series (e): use the condition  for convergence of a geometric series, and the formula for the sum to infinity of a convergent geometric seriesC2 – Algebra (a): use the remainder theoremC2 – Integration (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 – only the area between a curve and the *x*-axis appears in the reformed AS specificationC2 – Integration (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-estimateM1 – Force as a Vector (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 M1 – Force as a Vector (c): find and use perpendicular components of a force,… to calculate the magnitude and direction of a force M1 – Equilibrium of a Particle (b): understand and use the principle that a particle is in equilibrium if and only if… the sum of the resolved parts in any given direction is zeroM1 – Equilibrium of a Particle (d): … understand the concept of limiting friction and limiting equilibrium, recall the definition of coefficient of friction, and use the relationship  or  as appropriateM1 – Newton’s Laws of Motion (b): model, in suitable circumstances, the motion of a body… on an inclined plane, as motion with constant acceleration and understand any limitations of this modelM1 – 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 coalesceS1 – Probability (a): understand the terms permutation and combinationS1 – Probability (b): solve problems about selections S1 – Probability (c): solve problems about arrangements of objects in a line, including those involving *(i)* repetition, *(ii)* restrictionS1 – Probability (d): evaluate probabilities in simple cases by … calculation using permutations and combinationsS1 – Probability (f): … calculate and use conditional probabilities in simple cases 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 appropriateS1 – Discrete Random Variables (d): use formulae for the expectation and variance of the binomial distribution, and for the expectation of the geometric distributionS1 – Bivariate Data (a): calculate, both from simple raw data and from summarised data, the product moment correlation coefficient for a set of bivariate dataS1 – Bivariate Data (b): understand the basis of Spearman’s coefficient of rank correlation, and calculate its valueS1 – Bivariate Data (c): interpret the value of a product moment correlation coefficient or of Spearman’s rank correlation coefficient in relation to the appearance of a scatter diagram, with particular reference to values close to -1, 0, 1S1 – Bivariate Data (d): understand that the value of a correlation coefficient is unaffected by linear transformations (coding) of the variablesS1 – Bivariate Data (e): understand the difference between an independent (or controlled) variable and a dependent variableS1 – Bivariate Data (f): understand the concepts of least squares regression lines… in the context of a scatter diagramS1 – 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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