AS Additional Further Mathematics Personalised Learning Checklist

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| **Content/Topic: General** | **Red** | **Amber** | **Green** |
| Candidates must recognise all the mathematical facts, concepts and techniques that are needed, and select appropriate ones to use in a wide variety of contexts |  |  |  |
| Candidates need to manipulate mathematical expressions and use graphs, sketches and diagrams, all with high accuracy and skill. They should use mathematical language correctly and proceed logically and rigorously through arguments or proofs |  |  |  |
| When confronted with unstructured problems they should devise and implement an effective solution strategy. If errors are made in calculations, these should be noticed and corrected |  |  |  |
| Candidates must recognise the standard models that are needed, and select appropriate ones to represent a variety of situations in the real world. They should correctly refer results from calculations using the model to the original situation and give sensible interpretations of their results in the context of the situation |  |  |  |
| They should make intelligent comments on the modelling assumptions and possible refinements to the model |  |  |  |
| Candidates must comprehend or understand the meaning of translations of common realistic concepts. They make sensible comments or predictions |  |  |  |
| They can distil essential mathematical information from extended pieces of prose with mathematical content and can comment meaningfully on the mathematical information |  |  |  |
| Candidates should make appropriate and efficient use of contemporary calculator technology and be aware of any limitations to their use. They present results to an appropriate degree of accuracy |  |  |  |
| **Content/Topic: FP3 Module** | **Red** | **Amber** | **Green** |
| **VECTORS -**  Be able to form the vector product of two vectors in magnitude and direction, and in component form  a × b = |a| |b| sin θ ň = ⌠ a2b3 – a3b2 **⎫**  ⏐a3b1 – a1b3 ⏐  **⎩** a1b2 - a2b1 ⌡  Understand the anti-commutative and distributive properties of the vector product  Know the significance of a×b=0 |  |  |  |
| **VECTORS -**  Be able to find the line of intersection of two planes.  Be able to determine whether two lines in three dimensions are skew or intersect and to find the point of intersection if there is one  Be able to find the shortest distance from a point to a line in 2 or 3 dimensions from a line or from a plane  Be able to find the shortest distance from a point to a plane *(distance of point (α, β, γ) to plane n1x + n2y + n3z + d = 0 is [(n1 α + n2 β + n3 γ + d) / √( n12 + n22 + n32)]* |  |  |  |
| **VECTORS -**  Be able to use the scalar triple product to find the shortest distance between two skew lines  *The shortest distance between the two skew lines: r = a + λd and r= b + μe is DET[(a – b)****.****(d x e)/det(d x e)]* Be able to use the scalar triple product to determine whether or not two lines in 3D intersect |  |  |  |
| **MULTI-VARIABLE CALCULUS -**  Appreciate that the relation z = f (x,y) defines a surface in three dimensions  Be able to sketch contours and sections and know how these are related to the surface  Be able to find first order partial derivatives and use the conditions ∂z/∂x = 0 and ∂z/∂y = 0 to find the coordinates of stationary points on a surface |  |  |  |
| **MULTI-VARIABLE CALCULUS -**  Appreciate that the relation g(x,y,z) =c defines a surface in three dimensions  *(Surfaces may be defined by z= f (x,y) or g(x,y,z) =c)*  Be able to find grad g, and to evaluate this at a point on the surface to give a normal vector and to find the equations of the normal line and tangent plane at a point on the surface  **MULTI-VARIABLE CALCULUS -**  δz ≈ ∂z/∂x δx + ∂z/∂y δy and its Application to Errors  Appreciate that the tangent plane gives a local approximation to the surface, and hence that  δz ≈ ∂z/∂x δx + ∂z/∂y δy and be able to use this, or the similar result for functions of more than two variables, to estimate the consequence of errors in these variables |  |  |  |
| **DIFFERENTIAL GEOMETRY -**  Be able to calculate arc length using Cartesian, parametric and polar co-ordinates  Be able to calculate the volume and curved surface area of a solid of revolution using Cartesian or parametric co-ordinates *(Rotation about x- or y-axis only)*  Be able to find the envelope of a family of curves by eliminating p between f(x, y, p) = 0 and ∂f/∂p(x,y, p) = 0  Understand the use of arc length and inclination of tangent as intrinsic coordinates  Be able to work with intrinsic equations in simple cases *(eg s = c tanψ (catenary) or s = 4a sinψ (cycloid))* |  |  |  |
| **DIFFERENTIAL GEOMETRY**  Be able to use the definitions of curvature and radius of curvature  *(κ = dψ/ds and ρ = ds/dψ the Cartesian and parametric forms are also required)*  Be able to find the centre of curvature *(c = r + ρ* *ň) and b*e able to find the evolute as the locus of the centre of curvature and as the envelope of the normals |  |  |  |
| **GROUPS**  Understand the group axioms and the associated language *(the terms binary operation, closed, associative, identity, inverse, abelian)*  Be familiar with examples of groups, and of the use of group tables *(symmetries of geometrical figures, residue classes, permutations, matrices)*  Understand the meaning of the term cyclic group, and how a single element can generate such a group  Understand the terms order of a finite group, order of an element and the term subgroup |  |  |  |
| **GROUPS**  Understand that different situations can give rise to essentially the same structure  *(Concept and illustrations only)*  Be able to specify an isomorphism in simple cases *(be able to decide whether two groups of order 4 or 6 are isomorphic)*  Understand and be able to use Lagrange's theorem *(In a finite group, the order of a subgroup divides the order of the group. The corollary that the order of an element divides the order of the group)* |  |  |  |
| **Content/Topic: M3 Module** | **Red** | **Amber** | **Green** |
| **CIRCULAR MOTION -**  Understand the language associated with circular motion *(the terms tangential, radial and angular speed, radial component of acceleration, tangential component of acceleration – θ and ω for angular speed)*  Identify the force(s) acting on a body in circular motion *(equations of motion in simple cases v = rθ or rω) and b*e able to calculate acceleration towards the centre of circular motion *( v2/r and rθ2 )* |  |  |  |
| **CIRCULAR MOTION -**  Be able to solve problems involving circular motion with uniform speed *(eg a conical pendulum, a car travelling horizontally on a cambered circular track)*  Be able to solve problems involving circular motion with non-uniform speed  Be able to calculate tangential acceleration *(Newton’s 2nd law in tangential direction)*  Be able to solve problems involving motion in a vertical circle *(use of conservation of energy, and of F = ma in the radial direction)*  Identify the conditions under which a particle departs from circular motion *(eg when a string becomes slack, when a particle leaves a surface)* |  |  |  |
| **ELASTIC STRINGS and SPRINGS -**  Be able to calculate the stiffness or modulus of elasticity in a given situation *(T = kx where k is the stiffness)*  Be able to calculate the tension in an elastic string or spring *(energy = λx / l0 where λ is the modulus of*  *elasticity and l0 the natural length)*  Be able to calculate the equilibrium position of a system involving elastic strings or springs *(eg a weight suspended by a spring)*  Be able to calculate energy stored in a string or spring  *(½ λx2 / l0 or ½kx2)*  Be able to use energy principles to determine extreme positions *(application to maximum extension for given starting conditions in a system, whether horizontal or vertical)* |  |  |  |
| **MODELLING OSCILLATIONS (SIMPLE HARMONIC MOTION) -**  Recognise situations which may be modelled by SHM  Be able to recognise the standard form of the equation of motion of SHM and formulate it as appropriate  Be able to recognise the SHM equation expressed in non-standard forms and to transform it into the standard form by means of substitution and recognise the solution of the SHM equation in the form x = asin(ωt+ε) and be able to interpret it |  |  |  |
| **MODELLING OSCILLATIONS (SIMPLE HARMONIC MOTION) -**  Recognise other forms of the solution of the SHM equation, and be able to relate the various forms to each other  Be able to select a form of the solution of the SHM equation appropriate to the initial conditions  Be able to verify solutions of the SHM equation using calculus  Be able to analyse motion under the action of springs or strings as examples of SHM and to calculate suitable constants to model given data by SHM equations |  |  |  |
| **VOLUMES of REVOLUTION -**  Be able to find the centre of mass of a compound body, parts of which are solids of revolution *(by treatment as equivalent to a finite system of particles)*  Be able to use calculus methods to calculate the centres of mass of plane laminae  Apply knowledge of centres of mass to simple cases of equilibrium  *(including composite bodies)* |  |  |  |
| **DIMENSIONS and UNITS -**  Be able to find the dimensions of a quantity in terms of M, L and T  Understand that some quantities are dimensionless  Be able to determine the units of a quantity by reference to its dimensions  Be able to change the units in which a quantity is given and use dimensional analysis as an error check  Use dimensional analysis to determine unknown indices in a proposed formula |  |  |  |
| **Content/Topic: D2 or M4 Module** | **Red** | **Amber** | **Green** |
| (this will be at the discretion/choice of the class) |  |  |  |