A2 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: FP2 Module** | **Red** | **Amber** | **Green** |
| **CALCULUS -**  The inverse functions of sine, cosine and tangent.  Understand the definitions of inverse trigonometric functions.  Differentiation of arcsinx, arccosx and arctanx  Be able to differentiate inverse trigonometric functions |  |  |  |
| **CALCULUS -**  Use of trigonometrical substitutions in integration. Recognise integrals of functions of the form  and  and be able to integrate associated functions by using trigonometrical substitutions |  |  |  |
| **POLAR CO-ORDINATES -**  Understand the meaning of polar co-ordinates and be able to convert from polar to Cartesian co-ordinates and vice-versa  Be able to sketch curves with simple polar equations, find the area enclosed by a polar curve and be able to find the area enclosed by a polar curve |  |  |  |
| **COMPLEX NUMBERS -**  Understand the polar (modulus-argument) form of a complex number, and the definition of modulus and argument and be able to multiply and divide complex number in polar form  Understand de Moivre's theorem and be able to apply de Moivre's theorem to finding multiple angle formulae and summing suitable series |  |  |  |
| **COMPLEX NUMBERS -**  Expression of complex numbers in the form  - understand the definition  and hence the form  The n nth roots of a Complex Number  Know that every non-zero complex number has n nth roots, and that in the Argand diagram these are the vertices of a regular n-gon  Know that the distinct nth roots of  are:  for k = 0, 1,…,  Be able to explain why the sum of all the nth roots is zero |  |  |  |
| **COMPLEX NUMBERS -**  Applications of Complex Numbers in Geometry - appreciate the effect in the Argand diagram of multiplication by a complex number and be able to represent complex roots of unity on an Argand diagram.  Be able to apply complex numbers to geometrical problems |  |  |  |
| **POWER SERIES -**  Maclaurin Series - be able to find the Maclaurin series of a function, including the general term in simple cases.  Appreciate that the series may converge only for a restricted set of values of x  Identify and be able to use the Maclaurin series of standard functions |  |  |  |
| **MATRICES -**  Be able to find the determinant of any 3x3 matrix and the inverse of a non-singular 3x3 matrix  Be able to solve a matrix equation or the equivalent simultaneous equations, and to interpret the solution geometrically  Understand the meaning of eigenvalue and eigenvector, and be able to find these for 2x2 or 3x3 matrices whenever this is possible |  |  |  |
| **MATRICES -**  The Use of the Cayley-Hamilton Theorem - understand the term characteristic equation of a 2x2 or 3x3 matrix  Understand that every 2x2 or 3x3 matrix satisfies its own characteristic equation |  |  |  |
| **MATRICES -**  Diagonalisation of 2x2 and 3x3 Matrices  Be able to form the matrix of eigenvectors and use this to reduce a matrix to diagonal form  Be able to find powers of a 2x2 or 3x3 matrix |  |  |  |
| **HYPERBOLIC FUNCTIONS -**  Hyperbolic functions - definitions, graphs, differentiation and integration  Understand the definitions of hyperbolic functions and be able to sketch their graphs  Be able to differentiate and integrate hyperbolic functions |  |  |  |
| **HYPERBOLIC FUNCTIONS -**  Inverse Hyperbolic Functions (including the logarithmic forms)  Understand and be able to use the definitions of the inverse hyperbolic functions  Be able to use the logarithmic forms of the inverse hyperbolic functions and be able to integrate  and  and related functions |  |  |  |
| **Content/Topic: M2 Module** | **Red** | **Amber** | **Green** |
| **A MODEL FOR FRICTION -**  Understand that bodies in contact may be subject to a frictional force as well as a normal contact force *(normal* *reaction)* and be able to draw a force diagram  Understand that the total contact force between surfaces may be expressed in terms of a frictional force and a normal contact force *(normal reaction)* |  |  |  |
| **USING EXPERIMENTAL RESULTS -**  Understand that the frictional force may be modelled by ***F = μ R***  Be able to apply Newton's Laws to problems with friction |  |  |  |
| **MOMENTS OF FORCES -**  Be able to draw a force diagram for a rigid body  Understand that a system of forces can have a turning effect on a rigid body  Be able to calculate the moment about a fixed axis of a force acting on a body  Understand and be able to apply the conditions for equilibrium of a rigid body to the solution of problems and be able to identify whether equilibrium will be broken by sliding or toppling in simple cases |  |  |  |
| **CENTRE OF MASS -**  Be able to find the centre of mass of a system of particles of given position and mass and appreciate how to locate centre of mass by appeal to symmetry  Be able to find the centre of a mass of a composite body by considering each constituent part as a particle at its centre of massuse the position of the centre of mass in problems involving the equilibrium of a rigid body |  |  |  |
| **WORK, ENERGY AND POWER -**  Be able to calculate the work done, both by a force which moves along its line of action and by a force which moves at an angle to its line of action  Be able to calculate kinetic energy, understand the term mechanical energy and understand the work-energy principle  Understand the terms conservative and dissipative forces |  |  |  |
| **WORK, ENERGY AND POWER -**  Be able to calculate gravitational potential energy and be able to solve problems using the principle of conservation of energy  Understand that the power of a force is the rate at which it does work and be able to apply the concept of power to the solution of problems |  |  |  |
| **MOMENTUM AND IMPULSE -**  Be able to calculate the impulse of a force as a vector and understand the concept of momentum and appreciate that it is a vector quantity  Be able to apply the Impulse-Momentum equation to problems and derive the conservation of momentum equation for a collision between two particles in one dimension and apply the principle of conservation of momentum to direct impacts within a system of bodies  Understand that a system subject to no external force conserves its momentum |  |  |  |
| **MOMENTUM AND IMPULSE -**  Be able to solve problems using both momentum conservation and Newton's Experimental Law and understand that mechanical energy is not conserved during impacts (unless *e* = l) and be able to find the loss of mechanical energy |  |  |  |
| **MOMENTUM AND IMPULSE -**  Understand Newton's Experimental Law and the meaning of coefficient of restitution, and be able to apply it in modelling impacts  Understand that in an oblique impact between an object and a smooth plane, the impulse acts in a direction normal to the plane and know that the velocity of the object parallel to the plane is unchanged by impact and that the direction of the component of the velocity perpendicular to plane is reversed and that its magnitude is multiplied by the coefficient of restitution  Be able to calculate the loss of kinetic energy in an oblique impact and to solve problems involving oblique impact |  |  |  |
| **FRAMEWORKS -**  Be able to find the internal forces in a framework of light, pin-jointed rods by applying the conditions for equilibrium at the pin-joints and determine which rods in a framework are in compression and which in tension |  |  |  |
| **Content/Topic: DE Module** | **Red** | **Amber** | **Green** |
| **MODELLING WITH DIFFERENTIAL EQUATIONS -**  Understand how to introduce and define variables to describe a given situation in mathematical terms *(model real-life situations with differential equations including rate of change of x with respect to time = ẋ)*  Be able to relate 1st and 2nd order derivatives to verbal descriptions and so formulate differential equations *(not restricted to those which can be solved analytically)*  Know the language of kinematics, and the relationships between the various terms *(including acceleration = v.dv/ds, v = ds/dt and a = dv/dt and d2s/dt2)*  Know Newton's 2nd law of motion *(F = ma) and u*nderstand how to determine the order of a differential equation |  |  |  |
| **MODELLING WITH DIFFERENTIAL EQUATIONS -**  Be able to interpret the solution of a differential equation in terms of the original situation and appreciate the difference between a general solution and a particular solution, that is one which satisfies particular prescribed conditions  Understand the significance of the number of arbitrary constants in a general solution and be able to investigate the effect of changing a differential equation on its solution |  |  |  |
| **TANGENT FIELDS -** *(direction field has the same meaning)*  Be able to sketch the tangent field for a 1st order differential equation and be able to interpret it and be able to interpret the curve of the solution corresponding to particular conditions and to identify isoclines. Be able to use them in sketching and interpreting tangent fields |  |  |  |
| **FIRST ORDER DIFFERENTIAL EQUATIONS -**  Be able to find both general and particular solutions of a 1st order differential equation with separable variables and be able to solve 1st order linear differential equations with constant coefficients *(equations of the form y’ + ay = 0 and y’ + ay = f(x) where a is a constant)*  Be able to distinguish differential equations where the integrating factor method is appropriate, and to rearrange such equations if necessary *(equations in the form: dy/dx + P(x).y = Q(x))*  Be able to find an integrating factor and understand its significance in the solution of an equation *(Integrating factor e ∫ P dx )*  Be able to solve an equation using an integrating factor and find both general and particular solutions |  |  |  |
| **NUMERICAL METHODS -**  Be able to use step by step methods (e.g. Euler's method) to solve 1st order differential equations (including simultaneous equations) where appropriate |  |  |  |
| **SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS -**  Be able to solve homogenous 2nd order differential equations, using the auxiliary equation and complementary function *(equations of the form*  *y′′ + ay′ + by = 0 where a and b are constants)* |  |  |  |
| **SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS -**  Be able to solve the general 2nd order linear differential equation, by solving the homogeneous case and adding a particular integral *(equations of the form*  *y′′ + ay′ + by = f(x) where a and b are constants)*  Be able to find particular integrals in simple cases.  Appreciate the relationship between different cases of the solution and the nature of the roots of the auxiliary equation, and be able to interpret these different cases graphically *(cases where f (x) is a polynomial, trigonometric or exponential function)*  Be able to solve the equation for simple harmonic motion, ẍ + ω(x + k) = 0 and be able to relate the various forms of the solution to each other  Appreciate that the same methods can be extended to higher order equations and be able to do so in simple cases |  |  |  |
| **SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS -**  Be able to model damped oscillations using 2nd order linear differential equations, and understand the associated terminology  Be able to interpret the solutions of equations modelling damped oscillations in words and graphically  *(the damping will be described as ‘over-‘, ‘critical’ or ‘under-‘ according to whether the roots of the auxiliary equation are real distinct, equal or complex)* |  |  |  |
| **SIMULTANEOUS DIFFERENTIAL EQUATIONS -**  Model situations with one independent variable and two dependent variables which lead to 1st order simultaneous differential equations, and know how to  solve these by eliminating one variable to produce a single, 2nd order equation *(Applications such as predator-prey models)*  Appreciate that the same method can be extended to more than two such equations, leading by elimination to a single higher order equation |  |  |  |